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THE COMMON FLEA.*—II.

By E. A. BUTLER.

THE digestive apparatus of a flea (Fig. 4) consists of parts very similar in their arrangement and function to those of the cockroach, and therefore needs no detailed description. The œsophagus is a rather short and narrow tube leading into a thick-walled gizzard, which, again, opens by its broader end into a capacious bag, the stomach, big enough to hold a large draught of blood, such as the insect is only too eager to suck in whenever it can get the opportunity. At the junction of the stomach with the intestine are four long, thin, blind tubes, the Malpighian tubules. The hinder end of the intestine expands into an inverted pear-shaped cavity, the rectum, on the walls of which are six oval glands.

The alimentary canal, when gorged with blood, can be rapidly emptied by the insect, and its contents ejected with considerable force, when a new and good supply of food presents itself before the last meal is disposed of. The dark stains on linen, that indicate where fleas have been, consist of their dried excrement, and are composed of the undigested remains of the blood corpuscles contained in the food. Judging from the fact that rooms that have long been unoccupied are sometimes found to be swarming with fleas, it would seem that the perfect insects can subsist for a time without their customary food, although they are rapacious and insatiable enough when it is obtainable. And even under ordinary circumstances their living must not unfrequently be precarious, and their meals most irregular. As is well known, it is not every human being that they regard as fit to supply them with nutriment; some individuals they seem instinctively to avoid, whether by reason of a greater thickness and toughness of skin, or of something distasteful in the blood, or from some other cause, it is impossible to say. That they should prefer a host with a soft and delicate skin is only natural, and is evidenced by their marked partiality for females and young children, though it must not be forgotten that some of this apparent partiality may be due to the extra facilities that are afforded to the parasites, in the case of these sections of the community, by the character of the clothing, the greater looseness of which renders them easier subjects for the fleas to gain access to and therefore to operate upon.

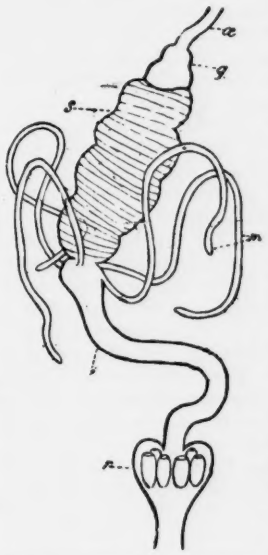

FIG. 4.—DIGESTIVE APPARATUS OF DOG'S FLEA. *œ*, œsophagus; *g*, gizzard; *s*, stomach; *m*, malpighian tubules; *i*, intestine; *r*, rectum. (After Landois.)

In consequence of the compression of the body and the comparative transparency of the skin, many details of internal anatomy may be made out in the living flea, if it be examined under the microscope with good illumination by transmitted light. The tracheæ, or breathing tubes, can thus be very easily traced, even down to many of their finer branches, and the large trunks that traverse the length of the body are especially conspicuous objects; large branches may also be easily seen running down the legs. If the flea is confined so that it can only move slightly, the contraction of the muscles, especially in the coxæ, can be watched without any difficulty, as any little twitchings occur in the legs. A living flea is a very pretty object when viewed with polarised light.

The original photographs from which the enlargements in the accompanying plate were taken were obtained from specimens prepared for the microscope, and therefore completely flattened. In the process of mounting, the thoracic segments unavoidably become slightly dislocated from their natural position; this is especially noticeable in the male. The greater part of the contents of the body also have been dissolved out, in order to increase the transparency of the object, and hence very little of the internal anatomy can, in these specimens, be seen. The most prominent object in this connection is the reproductive apparatus of the male; the bars and coiled threads at the hinder extremity are all parts of these organs, and are really internal in position, though they hardly seem so. The coiled threads are attached to the part of the organ that can be protruded.

We have now to trace the life history of the flea. The eggs are oval, whitish, sticky things, and though, of course, actually minute, are yet rather large in proportion to the size of the insect itself, their longest diameter being about $\frac{1}{40}$th of an inch, and the shortest $\frac{1}{60}$th. So far as the human species is concerned, the eggs appear to be laid, not upon the body or clothes of the host, but amongst

* The plate illustrating this paper has been made from photographic enlargements of a male and female flea prepared for the magic lantern by Messrs. Frederic Newton & Co., Opticians, of No. 3, Fleet Street, E.C.

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rugs, mats, and other accumulators of dust and dirt. It is commonly believed that cats and dogs bring fleas into a house, and there is certainly good evidence that at least their own parasites may be introduced in this way. For example, Mr. S. J. McIntire states that, wishing to obtain some eggs of the cat's flea, he placed, late one night, a cloth for his cat to lie upon, and early in the morning inspected it in order to collect any eggs that might have been deposited. On the first night, 62 eggs were obtained, on the second 78, on the third 67, and on the fourth 77, a total of 284 eggs from one cat in the course of four nights! No doubt many of these, if left to themselves, would never have reached maturity; still the number is sufficiently startling, and, unless the animal in question was literally swarming with vermin, seems to indicate on the part of the cat's flea a fecundity considerably in excess of what is usually attributed to the human species, which is said to produce only about a dozen at a laying. Of course it by no means follows that the fleas which would have resulted from these eggs would have been troublesome to the human inhabitants of the house; in fact, considering the great zoological difference between man and the cat, the presumption would be in the other direction. It has, however, been asserted, that the cat's flea will attack a human host, but, however that may be, it is evident that, to be on the safe side, rooms in which cats and dogs are accustomed to lie, should be frequently swept, and that the sweepings should be burnt.

From the eggs are hatched, not brown, leaping fleas, but whitish, footless, worm-like maggots, whose bodies are set with long hairs (Fig. 5). Each larva consists of a

Fig. 5.—Larva of Cat's Flea (*Pulex felis*). (After Künckel.)

head and twelve segments, the last terminated by a pair of hooks. The head carries four tubercles, a pair of short antennæ, and a good pair of biting jaws (Fig. 6), for at this period of its life the young flea devours solid food; it is neither parasitic nor a blood-sucker. These little grubs are extremely lively creatures, wriggling about vigorously, and working themselves along by aid of their hairs and caudal hooks. They appear to feed upon dry animal substances of various kinds, some fragments of which they are pretty sure to find in the neighbourhood of their birth-place. At the end of the 17th century, Leeuwenhoek, to whom we owe some of the earliest recorded observations on fleas, kept a colony of larvæ, and fed them on the bodies of dead flies. About 50 years later, Rösel tried some larvæ with various substances, and found that they refused sawdust, both from old and fresh wood; and that so far from enjoying fresh blood, they became drowned in it when small quantities that had been extracted from a pigeon were offered them. He found, on the other hand, that they fed readily on the bodies of gnats, and on dried and pulverised blood, and these observations have since been confirmed by other observers. Bearing these facts

Fig. 6.—Biting Jaw of Flea's Maggot.

in mind, then, it is evident that, quite apart from the parasites of our domestic quadrupeds themselves, rugs, mats, or carpets, on which such animals lie, are likely, by the accumulation there of hairs, fragments of skin, &c., to constitute an environment eminently adapted to the propagation of human fleas, the larvæ of which would find there excellent pasturage. In this connection may be quoted an experience of Prof. Westwood, who discovered some larvæ in a very unexpected way. He says that, having dropped a very minute insect on the floor of his library, close to the spot where one of his spaniels was in the habit of lying, he was obliged, in order to find it, to sweep the carpet very carefully with a fine brush upon a piece of white paper. By so doing he found the insect he was in search of, and at the same time swept up what he was certainly not looking for, some small hairy, wriggling maggots, which he at once recognised as flea larvæ. From what he subsequently states, the Professor seems to imply that these were the larvæ, not of the canine species, but of the human flea. The frequent use of the broom, therefore, wherever cats and dogs habitually take up their quarters, is eminently desirable, and not the dustbin, but the fire, should be the final destination of all rubbish so swept up. It is obvious, also, that the frequent sweeping out and cleansing of kennels, especially at the edges and in the corners of the floor, would be helpful as a preventive measure towards ridding dogs of fleas.

In the form of its larva, the flea is in complete agreement with the order Diptera, the footless, jaw-bearing maggot being the usual type amongst flies.

The young flea does not enjoy a long larval life; in summer it becomes full-grown in about twelve days, and then spins a little cocoon wherein to become a pupa. This habit is apparently sometimes departed from, for Rösel records that some of his larvæ pupated without a cocoon. The cocoon is, of course, extremely minute, and to the silken threads of which it is composed are usually attached particles of dust or cotton or woollen fibre, whereby its identity is almost completely obscured. Inside the snug little abode the tiny maggot divests itself of its larval skin, and appears as an odd, humpbacked chrysalis (Fig. 7). In this the maggot shape has altogether disappeared, and the outline of the perfect form becomes evident. Legs for the first time appear, but they are quite useless, as, in common with the rest of the insect, they are encased in a thin investing pellicle, each leg being enclosed in a case of its own. In the character of its pupa the flea resembles the Hymenoptera (Ants, Bees, Wasps, &c.), and differs markedly from the generality of the Diptera.

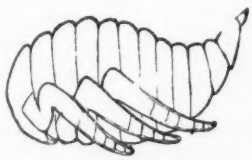

Fig. 7.—Pupa of Flea. (After Westwood.)

The developing flea remains in the condition of a pupa about a fortnight, of course taking no food during this time; it is at first dirty white, but soon darkens and assumes the well-known yellowish brown tint of the adult. From this pupa issues the perfect flea, and then, for the first time in its life, the spirit of bloodthirstiness comes upon it; never hitherto have its mouth-organs been adapted for taking liquid food, but now it is furnished with the extraordinary collection of lancets referred to in our former paper, and would find it equally difficult to partake of solid aliment. Those larvæ which hatch from eggs laid towards the beginning of winter do not pass through their metamorphoses so quickly, but spend the winter in the larval state, remaining in a torpid condition till the warmer

weather comes round and wakes them into renewed activity, and enables them to complete their cycle of changes. The flea, then, is an insect with a complete metamorphosis, therein differing *in toto* from both the bed-bug and the cockroach, and agreeing with dipterous flies in general.

Fleas do not seem to be confined to human habitations; there is a common belief that sandy seashores are infested by them, and that visitors to such spots may expect to return home "with company." In support of this notion may be adduced a statement made by Mr. T. J. Bold before the Tyneside Naturalists' Club about twenty-five years ago, to the effect that he saw fleas "dancing about quite merrily between Hartley and Whitley, and at other times they have been noticed quite frequently from South Shields to Marsden." There are, no doubt, many fragments of animal remains scattered about amongst loose sand, such as would serve very well for the larvæ to prey upon; but what the perfect insects can find to live upon in such situations is a mystery, for it can hardly be maintained that they frequent the spot with a view to possible human visitors.

That fleas can be excluded from houses by the use of odoriferous plants has long been a firmly believed tradition; witness the name of our common wayside plant, the Fleabane. The smoke of this when burnt was held to be particularly distasteful to fleas, which would forthwith abandon any premises in which they detected it. Several species of Compositæ have been credited with this potency; a preparation made from the leaves of a *Pyrethrum* from the Caucasus was at one time extensively used in Russia for driving away fleas. Wormwood (Artemisia) also was believed to possess similar powers, and Tusser has the following lines in illustration:—

> While wormwood hath seed, get a handfull or twaine,
> To save against March, to make flea to refraine;
> Where chambere is sweeped and wormwood is strown,
> No flea for his life dare abide to be known.

The "sweeped chambere" had no doubt quite as much to do with the matter as the wormwood. In folk-lore the first of March is intimately associated with fleas. It is still a practice in Kent to keep the doors shut on that day to prevent the fleas from entering, and in Sussex the door-steps are swept on the same day for the same purpose, and thus it is believed that immunity from their attacks will be secured for a twelvemonth.

(*To be continued.*)

THE LIFE-HISTORY OF A FERN.

By E. MANSEL SYMPSON, M.A., M.B. CANTAB.

MOST people like ferns, and now-a-days so many people keep them that a brief sketch of the life-history of a fern will probably possess interest for many readers of KNOWLEDGE. Ferns belong to the great group of Cryptogams. They owe that name to the fairly obvious fact that in them the organs of reproduction are not so visible, at all events at first sight, as is the case with the Phanerogams or flowering-plants. Another title must be added on to that of Cryptogams, to narrow it down to our more immediate subject. That word is "vascular"; by it we mean that these plants have fibro-vascular bundles in their stems, leaves, and roots (that is to say, supporting fibres and vessels which serve in part for transmitting nourishment from one portion of the plant to another). But our "division" must go farther, for the vascular Cryptogams are divided into Filicinæ (ferns and rhizocarps), Equisetineæ (the Horsetail group), and Lycopodineæ. Beginning, then, with a mature fern, we notice the little brown patches or streaks on the under surface of the fronds of many ferns, such as the Male Fern, the Hart's-tongue, the Polypody or the Maidenhair. These are called sori, and consist of masses of little capsules—the sporangia—made up of a thin envelope of cells, save at one part where a thickened band (sometimes merely a small accumulation, as in the Osmunda Fern) extends almost round the capsule. Compare one of these sporangia with one of those watches with

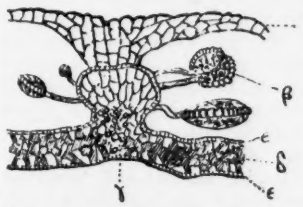

FIG. 1.—SECTION THROUGH A SORUS. α, Cap or Indusium; β, Sporangia; γ, Fibro-vascular bundle; δ, Green parenchyma; ε, Epidermis or skin.

FIG. 2.—PROTHALLIUM. α, Archegonia; β, Antheridia.

crystal faces and backs which were popular a few years ago. The crystal portion will represent roughly the thin-walled part of the sporangium, while the metal rim running round between the two plates may serve to indicate the position of the annulus, or thickened band of cells. These sporangia, as you might guess from the name, contain the spores, and the annulus plays a very important part in the eviction of these spores. When they are ripe, the ring contracts under certain conditions of the atmosphere, and, as the band is not complete, it tears the thin coat of the cells apart, and turns the spores out in to the world with considerable violence. In some instances these sporangia are covered by a kind of cap, called an indusium, which assumes varied forms; but sometimes it is absent, as in the case of the common Polypody. In each species of fern the spores are all of the same size, and all of them produce, when germinating, almost identical results. This fact, besides others relating to their growth, &c., serves to mark off ferns from the neighbouring order of Rhizocarps, in which there are two kinds of spores—macro- and micro-spores—and the product of germination of a large spore differs greatly and invariably from that of a small one. Returning to the fern spores, we notice that they are irregularly shaped bodies, generally dark-brown in colour, having a thin inner coat and a hard and thick outer one. The latter is useful in preventing extremes of weather and temperature from injuring them, and perhaps also in protecting them against the attacks of insects. When the spore has found a suitable resting-place, on a damp surface, with sufficient light and air and warmth, it begins to germinate. It swells up, and puts out a prolongation like a finger, covered by its inner coat, through an aperture in the outer coat, much in the same way as the pollen tube is protruded from the pollen-grain. This finger grows and broadens into a heart-shaped mass, a plate one cell thick, of green uniform cells, containing chlorophyll, and this it is which is commonly known as the prothallium of the fern. A very good idea of its appearance can be obtained from the common liverwort (*Marchantia Polymorpha*) so frequently found in damp court-yards. On the under surface of this prothallium, just behind the notch which gives it its heart

shape, appear the archegonia, which are the female elements of reproduction. Farther back, nearer to the point, so to speak, of the heart, still on the under surface, we find the root hairs, and among them the male elements, the antheridia. The development of these latter, as it is simpler, may be described first. They take their origin from some of the cells forming the plate of the prothallium, as a simple prolongation downwards, just as hairs grow on the stems or other parts of plants. Soon, however, in the middle of the free extremity of each of these, is seen a peculiar round body, of a different colour to the rest of the cell. These bodies rapidly surround themselves with a distinct cell-wall, and subdivide into a number of small cells. In these latter the antherozoids are formed, each consisting of a spirally-coiled thread, thickened at one end, and likewise at that end furnished with six long cilia. In due course the antheridia burst, the cells containing the antherozoids also open, and their contents, which move actively, are discharged. A few brief remarks on the comparative position and relation of these antherozoids will perhaps be in place here before proceeding to describe the development of the archegonia. In one of the lowest groups of Algæ—the Zygosporeæ—*sexual* reproduction as distinguished from vegetative reproduction is effected by the coalescence of two cells to form one, which is called a zygospore to denote its origin. No difference whatever can be observed between the two cells which thus come together; we cannot definitely say that one is male and the other female. At the same time, the mobility of the antherozoid is evidently foreshadowed in the cell which travels towards and pours its contents into the other; and this latter may be considered as representing, even in a rudimentary degree, the female egg-cell—the oosphere. This forms the earliest commencement of a differentiation, or unlikeness, between the male and female elements; a differentiation which proceeds more or less regularly upwards to the ferns, perhaps its highest point, whence it declines to the flowering plants.

FIG. 3.—SECTION OF PROTHALLIUM AND YOUNG FERN. A, Prothallium; B, First frond; C, First root.

Passing now, with a wide leap, to flowering-plants, we shall see why the word "declines" was used above. In them the pollen-grain, alighting on the stigma, puts forth the pollen-tube into the cellular mass of the stigma. The tube lengthens, and passing through the loosely-compacted tissue of the style, assisted, as has been suggested, by certain projections on the walls of the ovary, it eventually penetrates the micropyle of the ovule. Fertilisation is effected by a certain amount of the contents of the tube fusing with those of the two cells which lie nearest the entrance—the micropyle—and so passing into the oosphere beyond. Before this takes place, however, the protoplasm of the pollen-tube separates itself into an indefinite number of nuclei. These nuclei are the traces, as it were, of the complete cell-formation, which has been described in the development of the antheridia; they are the portions of the male organs of reproduction in flowering-plants which represent, in a degraded state, the antherozoids of which I have been speaking. Thus, from the undifferentiated cell of the humble alga to the highly organised antherozoid of the vascular Cryptogams, we can trace out the successive steps in that differentiation; while we can make out, with more difficulty but yet with comparative certainty, the stages which lead downwards from the antherozoid through the gymnosperms to the mere division of protoplasm in the pollen-tube of angiosperms (flowering-plants). The archegonia of the prothallium of a fern are nearly allied in form to those of the neighbouring order, the mosses. Each consists of a ventral portion, imbedded in the surrounding tissue and coherent with it, and of a short neck, through which two canal cells, as they are called, which subsequently undergo disintegration into mucilage, extend to the egg-cell.

Before describing the development of these archegonia, a brief mention of the comparative anatomy of these canal-cells may be of interest. In animal embryology, you will remember, during the growth of the egg-cell, or ovum, that is to say, during the series of changes whereby it becomes ripe for impregnation by a spermatozoon, two peculiar bodies, called *polar* bodies, are thrown off. These

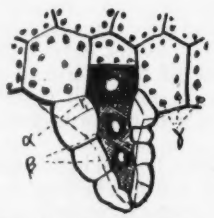

FIG. 4.—ARCHEGONIUM. α, Oosphere; β, Canal-cells; γ, Chlorophyll corpuscles.

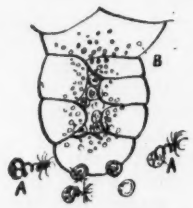

FIG. 5.—ANTHERIDIUM. A, Antherozoids; B, Chlorophyll corpuscles.

polar bodies are derived from the original nucleus of the egg called the germinal vesicle, and the portion of it left behind in the ovum is termed the *female pronucleus*. In the archegonium of a fern the canal-cells, so early severed from the egg-cell, correspond to these same polar bodies in animals, and the only explanation of the why and wherefore of this proceeding in the animal and vegetable economy is that given by the late F. M. Balfour. It is as follows:—After the formation of the polar cells (and the separation of the canal-cells), the remainder of the germinal vesicle within the ovum is incapable of further development without the addition of the nuclear part of the male element (spermatozoon or antherozoid), and he accounts for the prevalence of such a contrivance among plants and animals by assuming that it is to prevent the ovum developing by itself without fertilisation, somewhat analogous to the arrangements in plants to prevent self-fertilisation; the latter being no worse, to say the least, for the plant than the former.

The most frequent place for the spermatozoon to penetrate into the ovum is just where the polar bodies are formed; it seems as though they were guided by their presence, or the trace of them on the outside. Just so through the canal-cells the antherozoid has to make its way to the oosphere within the archegonium, which is composed of a layer of transparent cells, arranged in four tiers, surrounding a central cavity which extends into the thickened portion of the prothallium. Each one is developed from one cell of the prothallium, which swells up above the surface, and is soon separated into two by a horizontal partition. The upper of these two cells thus produced gives rise, by repeated divisions, to the neck of the archegonium, which, when fully developed, is composed of about twelve cells, built up in rings of four, one upon another, so as to form a kind of chimney-shaft having a central passage leading down to a cavity at its base. The lower of those two first formed cells becomes the central cell of the archegonium and, again dividing, cuts off two or more cells which fill up the neck, the canal cells so often mentioned above; while the largest and

lowest of these, remaining at the bottom of the cavity of the archegonium, becomes the oosphere or egg-cell. And from this oosphere, when fertilized by an antherozoid, a young plant is developed, which is what we ordinarily know as the fern. Thus, ferns are subject to what is called alternation of generations. The alternating generations may be distinguished by different names; thus our fern is termed the *sporophore* or spore-bearing generation, and from the perfectly asexual spores it produces is developed the prothallium, the *oophore* or egg-bearing generation, which produces, from the fertilization of the archegonium by the antherozoids of its antheridia, the large and complicated organism commonly known as the fern. The law of alternation of generations seems to be this: that a *sexual* generation, *i.e.* producing sexual organs, alternates with an *asexual* generation which produces only spores. This alternation of generations holds in nearly all the flowering plants. We get the following parts answering in a tolerably exact fashion to the two kinds of spores. The pollen-grain represents the microspore, which pollen-grain gives rise to the pollen-tube corresponding to the antheridium of the microspore's prothallium, while the division of protoplasm of the pollen-tube gives us an indication of the formation of antherozoids. Also, in the pollen-grain of flowering plants, and notably so in that

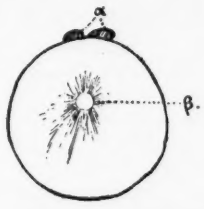

FIG. 6.—EGG OF ASTERIAS GLACIALIS. α, Polar Bodies; β, Female Pronucleus.

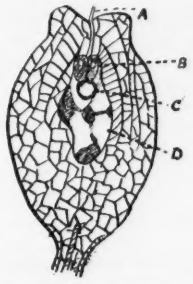

FIG. 7.—FERTILIZATION OF A FLOWERING-PLANT. A, Pollen tube; B, Synergadae; C, Egg-cell; D, Embryo-sac.

of Gymnosperms, there are two cells, one larger than the other, and usually it is this larger one which pushes itself out as the pollen-tube. Hence, the small cell, the vegetative part of the grain, taking no part in the formation of the pollen-tube, is equivalent to that portion of the prothallium of a microspore which does not produce antheridia; consequently the larger cell of the pollen grain corresponds to the part of the prothallium which does produce antheridia. Again, the embryo-sac of flowering plants, producing as it does by germination the egg-cell, presents a very striking similarity to the macrospore of a rhizocarp, which gives rise to the oosphere in the archegonium of its prothallium; while the merely vegetative portion of the products of the embryo-sac and of the macrospore is in both cases called the eudosperm.

Thus from the *sporophore* generation in the rhizocarps we have two kinds of spores giving rise to prothallia—the *oophore* generation—furnished with either antheridia or archegonia, and from the development of the fertilized oosphere in the latter we get the *sporophore*, the rhizocarp, again. Similarly, in flowering plants, the *sporophore* generation is what we know as the plant, producing macrospores, *i.e.* embryo-sacs, and microspores, *i.e.* pollen-grains; these give rise to the *oophore* generation, the prothallia in the one case forming oospheres (the last remnant of archegonia being found in the corpuscula of the Gymnosperms), and in the other, antheridia—the pollen-tube. By the fertilization of the egg by the pollen-tube, the *sporophore* generation is commenced again in the embryo plant, and the two generations, sexual and asexual, continue to repeat themselves in this order over and over again. What are ordinarily called the sexual organs of a flower do not deserve that title, for the stamen is simply a leaf modified to bear microsporangia, —the anthers—whence eventually the male organs will come, while the carpel is only a leaf modified to bear macrosporangia in a somewhat similar way.

We left the oosphere mature and ready for fertilisation by the antherozoids. They enter the canal of the archegonium, and as soon as the oosphere has been fertilised by them it begins to divide into four cells; of these the two lowest sub-divide into a plug-like, cellular mass, which imbeds itself firmly in the substance of the prothallium. Probably this, called the *foot*, takes up nourishment for the embryo from the prothallium. It also serves to distinguish cryptogams of the most differentiated kind from flowering plants generally, for in all the latter the *suspensor* is the organ corresponding to this foot. In some orchids this suspensor curiously enough actually grows out of the micropyle into the placenta, to absorb nutriment for the embryo. In several of the flowering plants the use of the suspensor seems to finish after a certain period, and its place is taken by what Dr. Charles Darwin termed "the peg," between the plumule and the radicle. The presence of this peg has rather complicated the subject, but Dr. Vines has been able to show, by comparative studies, that the suspensor of selaginella and of the flowering plants is homologous with the foot of the vascular cryptogams, seeing that it is derived from the same cell of the embryo. Of the remaining two upper cells, which also sub-divide, one gives rise to the rhizome—the stem of the young fern—while the other becomes its first rootlet. As the rhizome grows and develops its fronds, it rapidly attains a size vastly superior to that of the prothallium, which ceases to have any work to do, and disappears.

SOME PROPERTIES OF NUMBERS.

BY ROBT. W. D. CHRISTIE, Head Master, Wavertree Park College, Liverpool (Member of the Lond. Math. Soc., &c.).

Roots and Powers of Numbers.

IS the square root of 1234567 an integer? No; because the square of no integer can possibly end in the digits 2, 3, 7 or 8. This is easily shown as follows:—Square the ten digits 1, 2, 3, &c. successively, and we get numbers ending in all the digits except those given above, viz. the digits 0, 1, 4, 9, 6, 5.

The cube of an integer may end in any of the ten digits. It is curious, however, to note that the cube of any integer ending in the same six digits, viz. 0, 1, 4, 9, 6, 5, ends in the same digit as the number itself does; and moreover the cube of any integer ending in the four digits mentioned above, viz. 2, 3, 7, 8, ends in the same figures but in the reverse order 8, 7, 3, 2.

We can thus very easily determine by inspection the cube root of any perfect cube less than a million. *Ex. gr.*, Find the cube root of 912673 by inspection.

Pointing off as usual, we see at once that there must be two figures in the root, and that one of them is 7 (since the cube of 7 ends in 3), and the nearest cube root of 912 is 9; thus we easily get 97 as the required root.

The fourth power of an integer may end in the four

digits 0, 1, 6, 5 only, and consequently no integer ending in 2, 3, 4, 7, 8, 9 can have its fourth root an integer. It is useful to note that the fourth power of any prime (except 2 and 5) ends in *unity*. Thus $P^4 - p^4$ is divisible by 240, at least when P and p are prime numbers > 5.

Any power of 5, 6, or 10 or number ending in 5, 6, 0 ends in 5, 6 or 0. Also, since $5 = 1^2 + 2^2$, we have by Euler's Theorem 5^n = the sum of two integral squares where n is any integer whatever.

Thus $5^2 = 3^2 + 4^2$; $5^3 = 2^2 + 11^2 = 5^2 + 10^2$, &c. &c.

It is remarkable that the fifth power of any number ends in the same integer as the number itself does, thus $1^5 = 1$; $2^5 = 32$; $3^5 = 243$, &c.

This fact can be utilised:—The fifth root of 17,210,368 is an integer. Determine it by inspection. Pointing off as usual, we have two figures in the root, and the units' digits must be 8 for the reason given. And since 3^5 is > 172 we must have 2 in the tens' place. Thus we get 28 for the fifth root.

Again, Ball in his *History of Mathematics*, p. 262, says:—"There is no integral solution of the equation $x^n + y^n = z^n$ if n is any integer > 2. Euler proved it when $n = 3$, and Lagrange gives a proof when $n = 4$. It appears to be generally true. The riddle therefore awaits a solution."

Now, if $x^5 + y^5 = z^5$, and all are integers, we must also have $x + y = z$, or $(10m + z)$, and the equation may be solved.

If we proceed with the sixth, seventh, &c. powers of numbers, we shall find they are but repetitions of the squares, cubes, &c. So that we have the first, fifth, ninth $--4n$ - 3rd power of an integer ending in the same digit as the number itself.

Similarly $N^{2(2n-1)}$ cannot end in the digits 2, 3, 7, 8, but N^{4n-1} may end in *any* digit, and N^{4n} can only end in the digits 0, 1, 6, 5.

Circulating Decimals.

There is evidently a close connection between Prime Numbers and Circulating Decimals. The rules relating to the conversion of vulgar fractions into decimals are generally ignored in the ordinary arithmetics on account of their number and intricacy. In order to determine the periodicity of any vulgar fraction $1/N$ we can reduce the rules to two. If the vulgar fraction be of the Form $1/N = 1/2^x\ 5^y$ the decimal *terminates* after p figures from the decimal point, p being the greater of the numbers x and y. In all other cases it will *recur*, *e.g.* let $x = 3$, $y = 2$, then $1/N = 1/2^3\ 5^2 = 1/200 = \cdot 005$.

If $1/N$ be the vulgar fraction where N ends in any one of the digits 1, 3, 7, or 9 then if $(10^p - 1)/N$ or $(N^p + N - 1)/N$ be an integer p will give the periodicity. Thus, *e.g.*, if $N = 13$ we have $(10^p - 1)/13$ or $(4^p + 12)/13$ an integer when $p = 6$. Thus the number of figures in the period of $\frac{1}{13}$ will be 6.

Since the vulgar fraction is always supposed to be brought down to its lowest terms, a numerator would not affect the periodicity. The rule as usually given can only tell us that the number of figures in the period is equal either to $\phi(N)$ or to a sub multiple of $\phi(N)$ where $\phi(N)$ denotes the totitives of N, *i.e.* the number of numbers less than N and prime to it.

It is a curious fact that when N is a prime, the figures of the period of $1/N$ are divisible by 9. When the period is *even* it is also divisible by 11, and when the period contains $3n$ figures by 37, &c. This will be enlarged upon in a future number. Thus *e.g.* $\frac{1}{37} = \cdot\dot{0}2\dot{7}$ and $0 + 2 + 7 = 9$; $\frac{1}{41} = \cdot\dot{0}2439\dot{}$ and $0 + 2 + 4 + 3 + 9 = 18$; $\frac{1}{31} = \cdot\dot{0}76923\dot{} = 27$; $\frac{1}{79} = \cdot 0126582278481\dot{} = 54$; also $\frac{1}{83}$; $\frac{1}{73}$, &c. &c.

Of course this is true generally when the period contains $N - 1$ figures. We may also note such fractions as $\frac{1}{683} = \cdot\dot{0}15873\dot{}$, where the second half is complementary to the first. Thus $3+5=8$; $7+1=8$; $8+0=8$; similarly $\frac{1}{47} = \cdot\dot{0}08547\dot{}$ gives us 555; $\frac{1}{21}$ give us 666, &c. &c.

I am now in a position to show one advantage that the method of division given in the November issue has over the ordinary method.

Find the periodicity of $\frac{1}{61}$. I set four boys simultaneously to work. Two do the first and third portions simultaneously by the ordinary method of division, and two others work the second and fourth portions by the new method till the figures meet or overlap. I then test the result by the nines.

Thus A's work would be to divide $1\cdot000 +$ by $61 =$ fifteen figures.

B's work would be to *multiply* by 6 and point off till he has fifteen figures, as explained in the November issue, thus:—

$$\begin{array}{r} 1000\cdot0 + \\ 6 \\ \hline 99\cdot4 \\ 24 \\ 97\cdot5 \\ 30 \\ \hline 7 \end{array}$$

Thus we have $+7540 =$ last four figures of 2nd portion.

C's work will be to divide $60\cdot000 +$ by 61 to fifteen figures, and D will multiply by 6 as follows by the new method:—

$$\begin{array}{r} +\ 999\cdot9 \\ 54 \\ \hline 94\cdot5 \\ 30 \\ \hline 96\cdot4 \\ 24 \\ \hline 7\cdot2 \end{array}$$

Thus we have $+2459 =$ last four figures of period.

The test is—

$$\begin{array}{r} +\ 7540 \\ +\ 2459 \\ \hline +\ 9999 \end{array}$$

We can thus set four boys to work one division question simultaneously, and it is interesting to note that we are able to obtain the middle figures of a quotient, and to work the question each way till the whole result is obtained. The full result is $\frac{1}{61} = \cdot\dot{0}16393442622950\dot{}$, (A, B, C, D) 819672131147540; 983606557377049, $180327868852459\dot{} = 9999 +$, &c., if A and C and B and D be added together. This result may be obtained in a much easier manner, as will be explained in another paper.

I will now describe a method of writing down mechanically the figures of the period of $1/N$ where N is a prime.

Primes > 5 end in the figures 1, 3, 7, or 9 only. It is easy to deduce from this that the last figure of the period of $1/N$ must be 9, 3, 7, or 1, respectively. Let us take $\frac{1}{19}$ for example. The *last* figure, according to the rule just given, is 1. All we have to do now is to multiply that 1 by 2; then multiply the product 2 by 2; then the product 4 by 2, and so on till the figures *repeat*. Thus the full period is $\frac{1}{19} = \cdot\dot{0}52631578947368421\dot{}$.

Again, write down mechanically the period of $\frac{1}{29}$. Multiply the last figure, which is 1, by 3. Then the product 3 by 3, and so on as before. Thus we get $\frac{1}{29} = :\dot{0}3448275862068965517241379\dot{3}1\dot{}$.

It is remarkable how interesting the dreariest part of arithmetic becomes when scientifically investigated.

This method suffices not only for Primes, but also for all numbers ending in the digits 1, 3, 7, or 9. But someone may say, How do you get the multipliers after you have obtained your last figure of the period? Nothing is easier. If your number N ends in 9 take the tens and add one. Thus, for $\frac{1}{79}$ our multiplier is 8 (since $7+1=8$), and we get the period of $\frac{1}{79} = \cdot\dot{0}126582278481\dot{}$.

For numbers ending in unity take the tens from the given number. Thus for $\frac{1}{41}$ take 4 from 41 = 37, which is our multiplier, and $\frac{1}{41} = \cdot\dot{0}2439\dot{}$.

For numbers ending in 3 multiply by 7, and for numbers ending in 7 multiply by 3, and in either case take the tens' digit from the given number. Thus, for $\frac{1}{13}$ we have 13 – 9 = 4, and the period = $\cdot\dot{0}76923\dot{}$, and the multiplier for 17 is 12. Thus, $\frac{1}{17} = \cdot\dot{0}588235294117647\dot{}$.

This remarkable rule is intimately connected with the new method of division, an elementary explanation of which I now give.

Let $N=PR$; say $2091=17R$.

$3N=3PR=10M_1+n_1$; say $6273=51R=10\times627+3$.

Let $X=(3P-1)/10$ say $5=(3\times17-1)/10$ in this case.

Then $3NX=3PRX=10M_1X+n_1X$.

And consequently $PR_1=M_1-n_1X$;

Say $17R_1=627-3\times5=612=10M_2+n_2$.

Similarly $PR_2=M_2-n_2X$;

Say $17R_2=61-2\times5=51=10M_3+n_3$.

Also $PR_3=M_3-n_3X$; say $17R_3=5-1\times5=0=10M_4+n_4$.

Now compare the process with the method described.

$$\begin{array}{ll} 627\cdot3 & =17R=10M_1+n_1 \\ 15 & \\ \hline 61\cdot2 & =17R_1=10M_2+n_2 \\ 10 & \\ \hline 5\cdot1 & =17R_2=10M_3+n_3 \\ 5 & \\ \hline 0 & =17R_3 \end{array}$$

Thus $2091\div17=123$.

Proceeding to the general case we get

$$PR_m=M_m-n_mX=10M_{m+1}+n_{m+1}.$$

Again we have—$M_1-n_1X=10M_2+n_2$.

Thus—$M_1-10M_2=n_1X+n_2$ . . . (1).

Again—$M_2-n_2X=10M_3+n_3$ . . . (2).

Thus—$10M_2=100M_3+10n_3+10n_2X$.

Therefore $M_1=100M_3+10n_3+10n_2X+n_1X+n_2$ (1 & 2).

$\therefore 3N=1000M_3+100R_3+100n_2X+10n_1X+10n_2+n_1$.

But $M_3=n_3X$.

Thus—$3N=(10Y+1)(100n_3+10n_2+n_1)$.

That is—$N=P(10n_3+10n_2+n_1)$.

And generally—$N=P(10^{m-1}n_m+10^{m-2}n_{m-1}\ldots+1)$.

The above is a proof for any divisor ending in 7. The process is exactly the same for divisors ending in 1, 3, or 9, and the only difference is in the value of X.

(*To be continued.*)

GROWTH AND DECAY OF MIND.

By the late R. A. Proctor.

(*Continued from page* 33.)

PERHAPS no more remarkable instance could be cited of the the possession of power in old age with the want of elasticity referred to in the last paper—than the remarkable papers on the universe, written by Sir W. Herschel in the years 1817 and 1818, that is, in his seventy-ninth and eightieth years. We find the veteran astronomer proceeding in the path which, more than forty years before, he had marked out for himself; but the very steadiness and strength of purpose with which he pursues it indicates the degree to which his mind had lost its wonted elasticity. In 1784 and 1785 he was traversing a portion of the same road. But then he was in the prime of his powers, and accordingly we recognise a versatility which enabled him to test and reject the methods of research which presented themselves to his mind. It was in those years that he invented his famous method of star-gauging, which our text-books of astronomy preposterously adopt as if it were an established and recognised method of scientific research. But Herschel himself, after trying it, and satisfying himself that it was unsound in principle, abandoned it altogether. In 1817 he adopted a method of research equally requiring to be tested, and, in my conviction, equally incapable of standing the test; but he now worked upon the plan he had devised, without subjecting it to any test. Nay, results which only a few years before he would certainly have rejected—for he did then actually reject results which were open to the same objection—passed muster in 1817 and 1818, and are recorded in his papers of those dates without comment. We may recognise another illustration of the loss of elasticity with advancing years, in the obstinacy—one may even say the perversity—with which Sir Isaac Newton, in the latter years of his life, adhered to opinions on certain points where, as has since been shown, he was unquestionably wrong, and where, had he possessed his former mental versatility, he must have perceived as much. Compare this with his conduct in earlier years, when for nineteen years he allowed his theory of gravitation to rest in abeyance—though he had fully recognised its surpassing importance—simply because certain minute details were not satisfactorily accounted for. Many other instances might be cited, were it worth while, to show how the mind commonly changes when approaching an advanced age, in a manner corresponding to that bodily change—that stiffness and want of elasticity, without any marked loss of power, which comes on with advancing years. That old age does not necessarily involve any loss of power for routine work, has been clearly shown in the lives of many eminent men of our own era.

It is well pointed out by Dr. Beard, in the lecture to which I have already referred, that "we must not expect to find at one age the mental qualifications due to another age—we must not look for experience and caution in youth, or for suppleness and versatility in age. We ought also to apportion to the various ages of a man the kind of work most suitable to them. Positions which require mainly enthusiasm and original work should be filled by the young and middle-aged; positions that require mainly experience and routine work, should be filled by those in mature and advanced life, or (as in clerkships) by the young who have not yet reached the golden decade. The enormous stupidity, and backwardness, and red-tapeism of all departments of governments everywhere, are partly due to the fact that they are too much controlled by age. The conservatism and inferiority of colleges are similarly explained. Some of those who control the policy of colleges—presidents and trustees—should be young and middle-aged. Journalism, on the other hand, has suffered from relative excess of youth and enthusiasm."

Before passing from the lecture of Dr. Beard, I shall venture to quote the remarks which he makes on the evidence sometimes afforded of approaching mental decay by a decline in moral sensitiveness. "Moral decline in old age," he says "means—'Take care; for the brain is giving way.' It is very frequently accompanied or preceded by sleeplessness. Decline of the moral faculties, like the decline of other functions, may be relieved,

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retarded, and sometimes cured by proper medical treatment, and especially by hygiene. In youth, middle age, and even in advanced age, one may suffer for years from disorders of the nervous system that cause derangement of some one or many of the moral faculties, and perfectly recover. The symptoms should be taken early, and treated like any other physical disease. Our best asylums are now acting upon this principle, and with good success. Medical treatment is almost powerless without hygiene. Study the divine art of taking it easy. Men often die as trees die, slowly, and at the top first. As the moral and reasoning faculties are the highest, most complex, and most delicate development of human nature, they are the first to show signs of cerebral disease. When they begin to decay in advanced life, we are generally safe in predicting that, if these signs are neglected, other functions will sooner or later be impaired. When conscience is gone, the constitution is threatened. Everybody has observed that greediness, ill-temper, despondency, are often the first and only symptoms that disease is coming upon us. The moral nature is a delicate barometer, that foretells long beforehand the coming storm in the system. Moral decline as a symptom of cerebral disease is, to say the least, as reliable as are many of the symptoms by which physicians are accustomed to make a diagnosis of various diseases of the bodily organs. When moral is associated with mental decline in advanced life, it is almost safe to make a diagnosis of cerebral disease. . . . . Let nothing deprive us of our sleep. Early to bed and late to rise, makes the modern toiler healthy and wise. The problem for the future is to work hard, and at the same time to take it easy. The more we have to do, the more we should sleep. Let it never be forgotten that death in the aged is more frequently a slow process than an event; a man may begin to die ten or fifteen years before he is buried."

When mental decay is nearing the final stage, there is a tendency to revert to the thoughts and impressions of former years, which is probably dependent on the processes by which the substance of the brain is undergoing decay. The more recent formations are the first, as we have seen, to crumble away, and the process not only brings to the surface, if we may so speak, the earlier formations—that is, the material records of earlier mental processes—but would appear to bring those parts of the cerebrum into renewed activity. Thus, as death draws near, men "babble of green fields," as has been beautifully said, though not by Shakespeare, of old Jack Falstaff. Or less pleasant associations may be aroused, as we see in Mrs. Grandmother Smallweed, when "with such infantine graces as a total want of observation, memory, understanding, and intellect, and an eternal disposition to fall asleep over the fire and into it," she "wiled away the rosy hours" with continual allusions to money.

The recollections aroused at the moment of death are sometimes singularly affecting. None can read without emotion the last scenes of the life of Colonel Newcome. I say the last scenes, not the last scene only, though that is the most beautiful of all. Everyone knows those last pages by heart, yet I cannot forbear from quoting a few sentences from them. "'Father!' cries Clive, 'do you remember Orme's *History of India*?' 'Orme's History, of course I do; I could repeat whole pages of it when I was a boy,' says the old man, and began forthwith. '"The two battalions advanced against each other cannonading, until the French, coming to a hollow way, imagined the English would not venture to pass it. But Major Lawrence ordered the sepoys and artillery—the sepoys and artillery to halt, and defend the convoy against the Morattoes." Morattoes, Orme calls them. Ho! Ho! I could repeat whole pages, sir.'" Later, "Thomas Newcome began to wander more and more. He talked louder; he gave the word of command, and spoke Hindustanee, as it to his men. Then he spoke words in French rapidly, seizing a hand which was near him, and crying, 'Toujours, toujours.' But it was Ethel's hand which he took. . . . . Some time afterwards, Ethel came in with a scared face to our pale group. 'He is calling for you again, dear lady,' she said, going up to Madame de Florac, who was still kneeling. 'And just now he said he wanted Pendennis to take care of his boy. He will not know you.' She hid her tears as she spoke. She went into the room, where Clive was at the bed's foot; the old man within it talked on rapidly for awhile; then again he would sigh and be still: once more I heard him say hurriedly. 'Take care of him when I'm in India,' and then with a heart-rending voice he called out 'Léonore, Léonore.' She was kneeling at his side now. The patient's voice sank into faint murmurs; only a moan now and then announced that he was not asleep. At the usual evening hour the chapel bell began to toll, and Thomas Newcome's hands outside the bed feebly beat time. And just as the last bell struck, a peculiar sweet smile shone over his face, and he lifted up his head a little, and quickly said, 'Adsum!' and fell back. It was the word we used at school when names were called, and lo! he whose heart was as that of a child, had answered to his name, and stood in the presence of The Master."

Sadder than death is it, however, when the brain perishes before the body. "How often, alas, we see," says Wendell Holmes, "the mighty satirist tamed into oblivious imbecility; the great scholar wandering without sense of time or place, among his alcoves, taking his books one by one from the shelves and fondly patting them: a child once more among his toys, but a child whose to-morrows come hungry, and not fullhanded—come as birds of prey in the place of the sweet singers of the morning. We must all become as little children if we live long enough; but how blank an existence the wrinkled infant must carry into the kingdom of heaven, if the Power that gave him memory does not repeat the miracle by restoring it."

TORTOISES AND TURTLES.

By R. LYDEKKER, B.A. Cantab.

TO many of us, the chief idea connected with turtles is that they are used to make turtle-soup; while in regard to tortoises our acquaintanceship is often limited to seeing a barrow-load of unfortunate specimens hawked about the streets, or to an individual or two kept in our own or a friend's garden, as a very unsociable kind of pet. We are also acquainted with this group of animals by means of tortoise-shell, either in the form of combs or various ornamental articles; although the exact nature of this commodity—which, by the way, comes from turtles and not from tortoises—is very frequently but very imperfectly known. Many people, indeed, have more or less hazy ideas as to what kind of animals tortoises and turtles really are. Thus, according to *Punch*, railway companies classify tortoises as insects; and the writer well recollects that during his undergraduate days his landlady purchased an unfortunate tortoise to take the place of a deceased hedgehog in the kitchen, for the purpose of eating black-beetles, and was immensely astonished when told that the tortoise was a vegetable feeder and had no sort of kinship with the hedgehog.

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Tortoises and turtles, or, as it is frequently convenient to call them, Chelonians (from the Greek name of the turtle), are, however, in reality a very remarkable group, or order, of the great class of Reptiles; and their form is so peculiar and so interesting that a short glance at some of their chief structural features cannot fail to be instructive. We are, indeed, accustomed to regard many extinct groups of reptiles, like the Fish-lizards* of the Secondary rocks, as more *bizarre* and strange than any forms which now inhabit the globe; but if we were to be made acquainted for the first time with tortoises from their fossil remains, we should certainly consider them as far more extraordinary than any other types; and it is highly probable that the palæontologist who first made known such a remarkable type of reptilian structure would be charged with having created a totally impossible monster.

The most striking and peculiar feature about tortoises and turtles is the more or less complete bony shell with which their body is protected; and on account of which they are noticed in the article on "Mail-clad Animals" published in the December number of KNOWLEDGE. The accompanying woodcut (Fig. 1) exhibits a typical Chelonian, as exemplified by a land-tortoise. In this creature we see a fully developed bony shell, within which the head, limbs, and tail can be retracted, so as to afford a perfect protection for the entire animal. We have just said that the shell of the tortoise is a bony one; but it will probably be at once objected that the "tortoise-shell" of commerce is about as unlike bone as it can well be. This apparent discrepancy can, however, be very readily explained. In a living tortoise, as is well shown in Fig. 1, the outer surface of the shell is completely covered over with a series of large shield-like horny plates, of which there is one row down the middle of the back, a lateral row on either side of this middle one; externally to which we have a series of marginal shields, forming the border of the upper half of the shell. Similar horny shields also cover the lower part of the shell, which we shall notice shortly. The solid bony shell underlies these horny shields; the relations of the horny and bony constituents of the protecting shell being shown in Fig. 2, where the outer horny shields have been stripped off, leaving distinct grooves on the underlying bones at the lines of junction with one another. Now it is these horny shields which form the "tortoise-shell" of commerce; in the land-tortoises they are, indeed, very thin, and of no economical value, but in one of the marine turtles, known as the Hawksbill, they become greatly thickened, and furnish the well-known "tortoise-shell," so remarkable for its translucency and the beautiful colouration formed by the mottled blending of a full reddish brown with a lemon yellow. It will be noticed from Fig. 1 that in the land-tortoises these horny shields have their edges in apposition; but in the young of the Hawksbill turtle they overlap one another like the slates on a roof, although in the adult they become united by their edges in the same manner as in the tortoises.

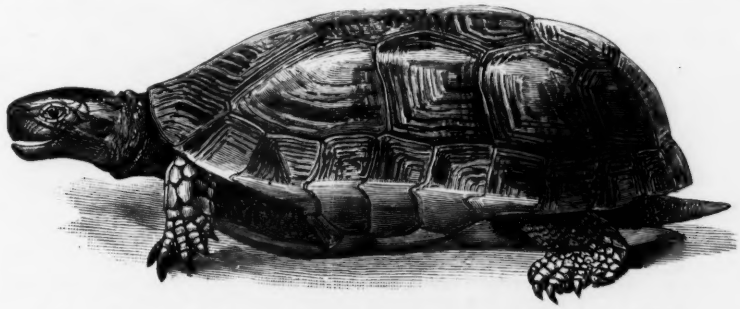

FIG. 1.—SIDE VIEW OF A LAND-TORTOISE, WITH THE HEAD AND LIMBS PROTRUDED FROM THE SHELL.

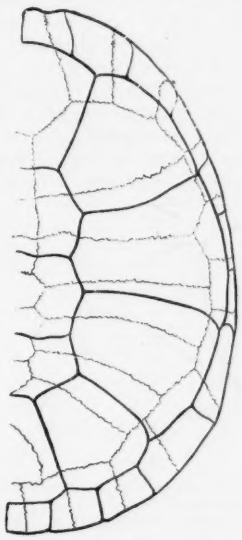

FIG. 2.—THE RIGHT HALF OF THE UPPER SHELL, OR CARAPACE, OF A TORTOISE, WITH THE HORNY SHIELDS REMOVED. The thick black lines show the boundaries of the horny shields, while the zigzag lines indicate the divisions between the underlying bony elements of the shell.

FIG. 3.—THE MIDDLE AND LEFT SIDE OF THE LOWER SHELL, OR PLASTRON, OF A LAND-TORTOISE.

Turning once more to Fig. 1, it will be seen, as we have already incidentally mentioned, that the shell consists of an upper vaulted portion covering the sides and back, which is technically known as the *carapace*; and also of a flattened lower plate protecting the chest and abdomen, to which the term *plastron*, or breast-plate, is applied. The carapace and the plastron are usually connected together by a comparatively short bony bridge, at the extremities of which are the notches for the fore and hind limbs, as is well shown in Fig. 1. In the land-tortoises this union between the carapace and plastron is quite complete; but in the marine-turtles, and also in some freshwater-tortoises, there is no bony union between the upper and lower portions of the shell. The characters of the plastron of the land-tortoises are well shown in Fig. 3, from which it will be seen that there are six pairs of symmetrical horny shields, arranged on either side of the middle line of the shell. This type of plastron is characteristic of nearly all the tortoises of the northern hemisphere; but in a smaller group, now confined to the southern hemisphere, there is an additional unpaired shield (Fig. 4, *i*, *gu*) dividing the

* See KNOWLEDGE for November 1889.

first or gular (*gu*) shields of the plastron. This additional, or intergular, shield, as it is termed, is very frequently of a battledore shape, as in Fig. 4.

In regard to the bones composing the upper shell, or carapace, it will be observed, from Fig. 2, that although they by no means correspond in contour with the overlying horny shields, yet that a decided general similarity of arrangement obtains between the two. Thus there is a single middle row of bones corresponding to the middle row of horny shields, although the bones are smaller and more numerous than the shields. Similarly there is a series of lateral bones on either side of the middle row; while in like manner the border of the carapace is formed

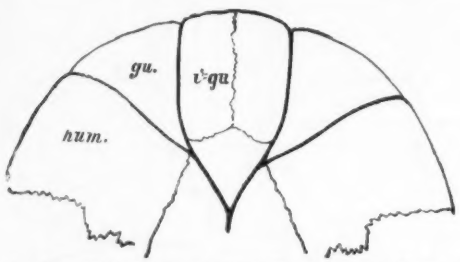

Fig. 4.—The Front Portion of the Carapace of a Freshwater-Tortoise of the Southern Hemisphere, with the Horny Shields removed. The thick lines indicate the boundaries of the horny shields.

of a series of marginal bones corresponding very closely with the marginal horny shields. The middle series of bones of the carapace are severally attached to the summits of the spines of the back-bone or vertebræ; while the lateral bones are nothing more than large expanded plates lying on the ribs, to which they are so completely welded that they are generally regarded as part of the same bone.

From this very brief glance at the structure of the Chelonian shell, we are now enabled to understand one of the most peculiar features of the organisation of these remarkable reptiles. This peculiar feature is, that whereas the shoulder-blade in all other animals lies entirely on the outer side of the ribs, in the tortoises and turtles it is situated within the cavity enclosed by the ribs and shell. Similarly the haunch-bones, which in all other animals lie close to the outer surface of the body, are likewise shifted within the cavity of the ribs and shell. To reach the shoulder-blades and haunch-bones the bones of the arm and leg are bent in a manner quite peculiar to this group of reptiles.

One other peculiarity in the bony structure of the group still remains to be mentioned. It is probably well known to all our readers that ordinary reptiles—such as crocodiles and lizards—are furnished with well developed teeth, which are frequently of great size. In all Chelonians, on the contrary, teeth are totally wanting, and their function is consequently performed by the margins of the jaws, which form sharp cutting edges, and are ensheathed with a coating of thick horn. This total absence of teeth is well shown in Fig. 1, and still better in Fig. 5, where the bones of the skull are represented with the flesh and skin removed. Another remarkable peculiarity of the Chelonian skull is found in the circumstance that the two sides of the lower jaw are firmly united together by bone at the chin, instead of being more or less completely separated, as in all other living reptiles. A third peculiarity is the development of the hinder extremity of the skull into a long spike-like process (Fig. 5, *o*), which gives a very characteristic contour to this part. The whole of the skull is covered over with horny shields (Fig. 1) in the living animal; so that in this respect the structure of the skull corresponds exactly with that of the shell.

In the entire absence of teeth, coupled with the horny sheathing of the jaw, and the solid union of the two bones of the lower jaw at the chin, tortoises agree with birds. Many, or all, of the birds of the Secondary geological epoch are, however, now known to have been provided with a complete set of teeth, and it is therefore highly probable that we shall some day find the fossil remains of extinct tortoises which were also furnished with these useful implements, since there appears to have been a tendency in many groups of animals, and more especially in birds and their near relations the reptiles, to lose their teeth. Thus the Fish-lizards of the Cretaceous rocks of the United States are all characterised by the absence of teeth; and a similar condition obtains in the Pterodactyles, or flying reptiles of the same deposits, by which feature they are widely distinguished from their Old World allies.

All the fossil tortoises and turtles at present known to us agree with existing types in their absence of teeth, as well as in the general characters of the shell; and we have at present (on the assumption that some mode of evolution is the true explanation of the mutual relationships of the different groups of animals) no evidence to connect the Chelonians very closely with any other type of reptiles. It is, however, very probable that the bony plastron of the tortoises is an extreme development of the peculiar system of so-called abdominal ribs found on the lower surface of the body in crocodiles and many extinct groups of reptiles.

Chelonians vary greatly in their habits, and in the nature of their food. Thus the land-tortoises, as their name implies, are terrestrial, although all of them can swim; while some closely allied types are aquatic. The feet of the former are provided with strong claws, and their food consists exclusively of vegetables, of which they consume a vast amount. The pond-tortoise of Southern Europe, which, together with the common Grecian land-

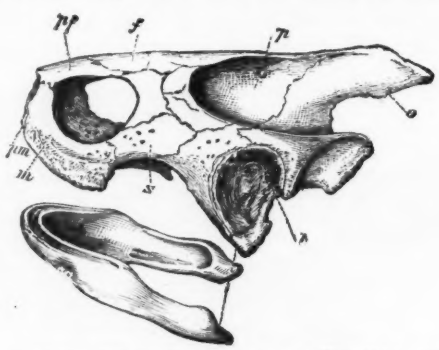

Fig. 5.—Left Side of the Skull of a Tortoise, with the Lower Jaw Displaced. *m*, *pm*, upper jaw; *s*, cheekbone; *t*, cavity of ear; *f*, *pf*, bones over the eye and nose-cavity; *p*, hollow of the temples; *o*, posterior spine.

tortoise, is the only European representative of the group, has, however, the feet webbed, and subsists on animal substances, such as worms. Many of the Indian water-tortoises are also carnivorous; this being especially the case with the well-known soft tortoises of the rivers of the warmer parts of the globe. In these forms the shell is unprovided with horny shields, but has the outer surface of the bones ornamented with a beautiful net-like sculpture, and merely covered with a thin skin. In the turtles, again, which are of marine habits, although they

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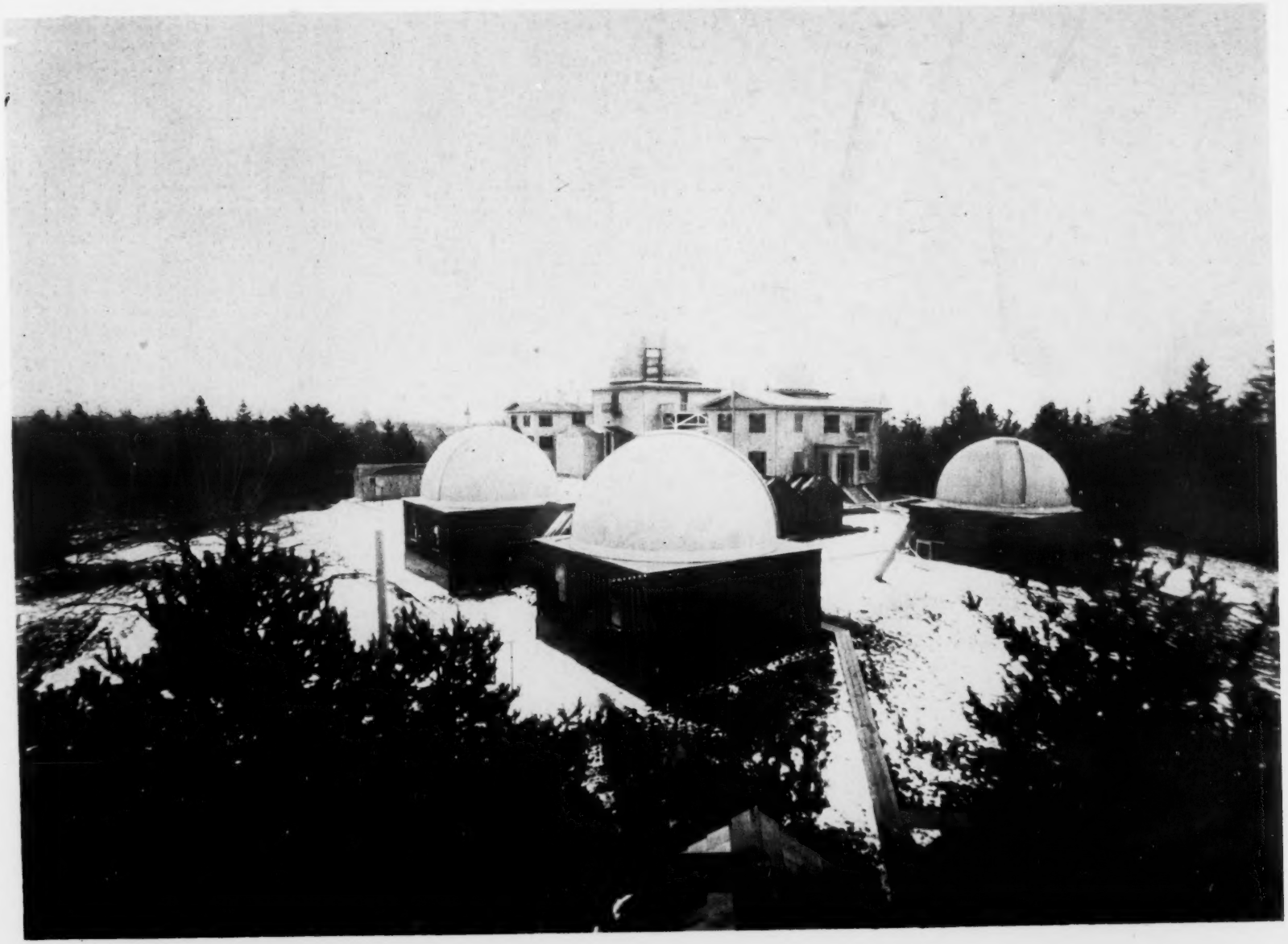

PHOTOGRAPH OF HARVARD COLLEGE OBSERVATORY (TAKEN THROUGH A PINHOLE WITHOUT A LENS).

Direct Photo ... Limited, 9, Barnsbury Park, N.

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resort to the shore to deposit their eggs, the limbs have all the toes enclosed in a common scaly integument, and these form paddles admirably adapted for swimming organs. While, however, the edible Green-turtle is of strictly herbivorous habits, the fierce Hawksbill is purely carnivorous. Another very remarkable group of marine Chelonians is now represented only by the so-called Leathery-turtle, which differs from all other living forms in that the shell is represented only by a carapace composed of a number of small bones closely joined together, and forming a mosaic-like structure which is totally unconnected with the ribs. The living Leathery-turtle attains a length of about five feet; but some allied fossil forms are estimated to have been as much as ten feet in length, and were thus veritable aquatic giants. The largest existing representatives of the true tortoises are, or were recently, found in certain islands of the Indian Ocean, and also in the well-known Galapagos (or Tortoise) Islands lying off the coast of South America. A magnificent series of these giant land-tortoises is now exhibited in the Natural History Museum at South Kensington. Many of these huge creatures, which have in some cases been completely exterminated by sailors, could readily walk off with a man seated on their back; and in the larger forms the length of the shell in a straight line is upwards of four feet. These dimensions were, however, vastly exceeded by certain fossil species found both in Northern India, the south of France, and elsewhere; the shells of some of these monsters attaining a length of six feet. The late Dr. Falconer, who was disposed to consider that the size was considerably greater than this, has indeed suggested that some of these huge tortoises may have lived on in India into the human period, and thus have given rise to the old Sanscrit legend that the earth was supported by a gigantic elephant standing upon the back of a still more gigantic tortoise; the legend being silent as to what constituted the support for the tortoise.

In conclusion, we may say a few words as to the classification of Chelonians, leaving, however, out of consideration the leathery-turtle and its allies, in regard to the serial position of which there has been been a considerable amount of discussion. Ordinary Chelonians are readily divided into two great groups, according to the manner in which the head is retracted within the shell. Thus, in the land-tortoises (Fig. 1) and their allies, the head is drawn directly within the margin of the shell by the bending of the neck in an **S**-like manner in a vertical plane. The plastron of this group is generally characterised by the absence of the unpaired intergular shield (Fig. 3), so that the two gular shields meet in the middle line. This group, as we have already mentioned, includes all the tortoises of the Northern Hemisphere, with the exception of the soft tortoises, and also the marine-turtles; it is, however, by no means confined to this hemisphere, although it is totally wanting in Australia. The name Cryptodirans, or hidden-neck tortoises, is applied to the members of this group. In the second great group, on the other hand, the neck is bent sideways, so that the head, when retracted, lies on one side of the front aperture of the shell near to one of the legs; and the presence of an intergular shield in the plastron (Fig. 4) is absolutely characteristic. The members of this group are termed Plurodirans, or side-necked tortoises, and, as we have said, are now exclusively confined to the Southern Hemisphere, and are the only Chelonians met with in Australia. In former epochs this group was, however, much more widely distributed, from which we may probably conclude that the Pleurodirans are an older and less specialised type than the Cryptodirans. A very remarkable gigantic fossil tortoise from Queensland and Lord Howe Island, which may probably be regarded as a member of the Pleurodiran section, is remarkable for having large horn-like prominences on the skull, and also for the bony rings with which the tail was protected, somewhat after the fashion of the Glyptodont Mammals (*see* KNOWLEDGE for December). Finally, the soft tortoises form a third group, allied to the Cryptodirans in the mode of retraction of the head, but distinguished by certain peculiarities in the structure of the skull and shell. From the presence of only three claws on the feet of the typical forms, this group is technically termed the Trionychoidea; and with this group we bring our brief remarks on tortoises to a close.

HARVARD COLLEGE OBSERVATORY.

By A. C. RANYARD.

THE accompanying plate was made from a photograph sent me by Prof. W. H. Pickering. It represents the rear of the celebrated Observatory of Harvard College, which is situated on a hill at Cambridge, a suburb of Boston, Massachusetts. The photograph was taken by Prof. W. H. Pickering without a lens. The image which fell upon the sensitive plate was formed by light from a pin-hole in the front of the camera; but though the sun was nearly setting when the photograph was taken, the exposure was only six minutes. The photograph was taken from the roof of a cottage to the north-west of the Observatory, and it will be noticed that the slates of the roof, and the wires, and other objects in the immediate foreground (with the exception of the fir trees, which probably moved with the wind during the exposure), are equally as sharp as objects at a distance. There being no lens, all objects are equally in focus and there is no distortion, or rather there is the same distortion as there should theoretically be in a hand-drawn picture; all objects appear as they would be seen projected on the tangent plane to a sphere by an eye situated at the centre of the sphere.

A photograph of any size may be taken with such an arrangement, but the farther the plate is from the pin-hole the larger will be the image of the object photographed, and the longer will be the time of exposure. Lord Rayleigh has shown that photographs may be obtained with holes considerably larger than pinholes, provided the plate is removed to a distance of some feet —the condition of sharp definition being that waves from different parts of the hole shall not interfere. No perceptible diminution in the sharpness of the image is apparent when the distance of the plate from different parts of the hole is less than a quarter of a wave length. The small observatories in the foreground contain various photographic instruments; that to the right contains an 11-inch photographic refractor, and the central dome covers Dr. Henry Draper's 28-inch silver or glass reflector; the other domes and huts cover the instruments with which Professor C. E. Pickering's photometric survey of the heavens has been made, as well as the instruments with which the series of photographs of stellar spectra have been taken.

The large dome at the centre of the main building covers the 15-inch refractor formerly used by Bond, which was in its day the largest instrument in America, and shared with the old 15-inch refractor of the St. Petersburg Observatory the honour of being the largest achromatic in existence. It was brought to America in 1847, and with it Bond discovered Hyperion, the 8th satellite of Saturn, in September 1848; a few days afterwards, Hyperion was independently discovered by Lassell,

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near Liverpool. With this 15-inch Bond also discovered the *crape*, or dark ring of Saturn, on the 11th November 1850; a discovery which was also duplicated in England, Mr. Dawes having observed it independently, before the news arrived in England, on the 29th of November.

For fifteen years the twin 15-inch telescopes of St. Petersburg and Harvard, both made by the same German maker, remained the largest refracting telescopes in existence. It was in America that the next step in advance was made by Alvan Clark, a portrait painter of Cambridgeport near to Harvard, who in 1862 made an excellent 18-inch refractor for the University of Mississippi. With it, before it was quite completed, Alvan Clark discovered the now well known companion of Sirius on the 31st of January 1862. The Civil War troubles having commenced, the telescope was never sent to its southern destination; but it has made its mark in the history of astronomy, for it fortunately fell into the hands of Mr. Burnham. It was purchased by a Chicago millionaire, who installed it in a handsome observatory, which he dedicated to the public in memory of his wife, whose maiden name was Dearborne. With this 18-inch in the Dearborne Observatory, Mr. Burnham discovered nearly a thousand new close double stars.

With the old 15-inch refractor of the Harvard Observatory Bond made his great drawing of the Orion Nebula and his important observations of the comet of 1861. Under Prof. E. C. Pickering's directorship the Harvard Observatory has been considerably enlarged. The work involved by his photometric and spectroscopic surveys of the Heavens requires a considerable addition to the staff of observers and computers. The additional expense involved is provided for by the guarantees of private individuals and voluntary subscriptions, a system which is more likely to be fruitful of beneficial results than the European plan of Government endowment, as it interests a large number of people in the work carried on, and their interest reacts beneficially upon the workers.

ORBIT OF ALGOL.

Some seven or eight years ago Prof. E. C. Pickering showed that there was considerable probability that the variation in the light of Algol was due to the periodical transits of a dark companion across the face of the bright star. He pointed out that the orbit of the bright star in such a system might be determined by spectroscopic observations, even when the distance of the system is not known. At a recent meeting of the Prussian Academy, Prof. Vogel stated that he had obtained six good photographs of the spectrum of Algol, three taken before minimum periods and three after. The three taken previously to the minimum periods show the lines decidedly displaced towards the red end of the spectrum, and the three taken after the minima show a similar displacement towards the blue end as compared with the lines in the solar spectrum. From careful measurements Prof. Vogel makes the motion of approach and recession of the bright star to be about equal and to amount to 27 miles per second. Assuming a circular orbit for the stars in a plane passing through the earth, Prof. Vogel derives the following elements for the system of Algol.

Diameter of Algol	1,074,100	English miles.
Diameter of the dark companion	840,600	,,
Distance of centres	3,269,000	,,
Speed of Algol in its orbit ...	27	,,
Speed of the companion in its orbit	56	,,

He makes the mass of Algol $\frac{4}{9}$ths that of our sun, and the mass of the companion $\frac{2}{9}$ths. This is on the assumption that the density of the two bodies is similar, and that there is a central transit. If the dark body transited above or below the centre of the luminous body, its relative size would be larger.

We regret to announce the death of Prof. Lorenzo Respighi, Director of the Osservatorio Campidoglio, Rome. He died on the 10th of December. By his death astronomy loses a most active worker and acute reasoner.

Notices of Books.

Hampstead Hill: Its Structure, Materials, and Sculpturing. By Prof. J. LOGAN LOBLEY, F.G.S. (Roper and Drowley.) Just as the modern student of history finds it necessary to have monographs on special periods, the lover of nature is glad of books dealing with the features of some small district with which he may be familiar. The museum-haunting specialist wants systematic memoirs, including all the species of some one group; but there are many genuine students who will also read with avidity works relating to outdoor natural history, to the geological history of the landscapes they admire, and on the occurrence and distribution through these well-known scenes of favourite plants, birds, or insects. It is to this auditory that Professor Lobley's elegant little book on Hampstead Hill will appeal. Matters topographical and archæological have been perhaps too rigidly excluded. The greater part of the book, that by Professor Lobley himself, is geological. The style is simple, and the geological chapters will be readily comprehended by anyone. It is needless to say, to those who know the writer's long and enthusiastic study of London geology, that they are accurate in detail. It might have been as well to refer to the fact that Professor Prestwich has recently proposed the separation of the sands of Hampstead from the main mass of those in the Bagshot area under the name "London Sands," and in a new edition we trust we may be indulged in a special chapter on the inferences from the Kentish Town Well, the section of which is given without comment on p. 61, and other deep borings, as to the oldest known condition of our London area.

It is, we presume, too late in the day to lament that local natural histories no longer have the irresponsibly gossipy form of White's *Selborne*, Knapp's *Journal of a Naturalist*, or Lees' *Botanical Looker-Out*, but must perforce be pervaded by the lists which rightly occupy so large a space in the *Proceedings* of local societies. In looking through the latter part of the work now under notice, however, we are constantly asking, like Oliver Twist, for more. Mr. Harting's list of the birds of Hampstead has indeed admirable, though brief, notes as to the frequency and mode of occurrence of the several species; but for the flora and insect-fauna, contributed by Dr. Wharton and the Rev. Dr. Walker, we have merely the bare lists.

We could hardly imagine a work speaking of the plants of Hampstead without any reference to Thomas Johnson. His *Ericetum Hamstedianum*, published in 1629, is the second printed account of a botanical excursion in England, and his *Enumeratio plantarum in Ericeto Hampstediano crescentium*, published in 1632, and recording 141 species, is the first local flora printed in this country. Then again Samuel Doody, who knew mosses "best of any man," was buried at Hampstead on December 3, 1706, his funeral sermon being preached by Adam Buddle, himself one of the most accurate of botanists, and one who made Hampstead one of his chief hunting-grounds.

We should be glad to see a complete Natural History of Hampstead. As Dr. Walker, whose lists are given, enumerates *Myriopoda*, *Arachnida*, and *Entomostraca* among the insect-fauna (!), we may direct his attention, and that of Professor Lobley, to a *Note on the Fauna of the Hampstead Ponds*, by B. B. Woodward, Esq., in the *Abstract of Proceedings of the West London Scientific Association* for March, 1876, which gives four amphibians, four fish, and ten mollusks, besides water insects and Crustacea. A few of the land-shells are recorded in Cooper's *Flora Metropolitana*, and assuredly a glance through the *Journal of the Quekett Microscopical Club* will afford a goodly list of micro-organisms.

Local residents—that is, Londoners generally—might do worse than purchase Professor Lobley's book and interleave it for their own additions.—G. S. BOULGER.

The River Karun; an Opening to British Commerce. By W. F. AINSWORTH, Ph.D., F.S.A., F.R.G.S. (W. H. Allen & Co.) The Karun is the chief river of Persia, and, in fact, from a commercial point of view, the only river of any importance. By a treaty recently concluded with the Shah, it has been opened to navigation, and consequently to British commercial enterprise. Flowing as it does into the head of the Persian Gulf, and connected as it is by canal with the Shat-al-Arab (the stream formed by the junction of the Euphrates and Tigris), it is manifestly a water-way of great importance in the development of the resources of a country which is perhaps as little known to the Western World as any of the great Asiatic empires. Under these circumstances, the publication of Dr. Ainsworth's book is most opportune. Having himself ascended the lower half of the river's course, the author is competent to speak of the capabilities of the route, and, for what his own experience failed to supply, he has liberally availed himself of that of other Persian travellers and explorers. The book consists of three parts; the first supplies very full details of the whole of the navigable course of the river, the towns on its banks, and the facilities they offer respectively as trading stations. The second discusses the question of land communication, a matter of equal importance with the water-way, and one which is apparently beset with great difficulties. The third part deals with the natural products of the country, which are sufficiently varied and valuable to form an attractive prospect for European enterprise. It is gratifying to learn that there has lately been great increase in the trade of the United Kingdom with Persia, the tonnage employed for that purpose in the Persian Gulf having increased in sixteen years from 1,200 to 70,000 tons, and it is to be hoped that the recent treaty may be the means of still further augmenting this total. On the opposite side of the country the trade is of course wholly in the hands of the Russians, who, by their Trans-caucasian railways and the navigation of the Caspian, are in a good position to monopolize the whole of its commerce unless a vigorous competition is started on the only other seaboard. To British capitalists, therefore, the question of the development of trade with Persia is largely one of rivalry with Russia. The country immediately around the Karun is, as Dr. Ainsworth points out, rich in antiquarian interest, and explorations would no doubt yield many interesting results. There seems to be a curious misprint on p. 111, where the river is stated to flow from S.S.W. to N.N.E., instead of in the opposite direction.

A Primer of Sculpture, By E. ROSCOE MULLINS. (Cassell and Co., London.) This is a charmingly illustrated little book written in a philosophic spirit and interesting to the general reader as well as to the art student who has adopted sculpture as a profession. Mr. Mullins is in favour of the student learning thoroughly the handicraft of his art, and, as soon as he has acquired sufficient dexterity in technique, applying himself to the study of nature and the interpretation of his own time rather than to the endless copying of classical models. Though students of science generally appreciate the great importance of being able to draw the objects they are studying, too few of them as yet recognise the great value which a model possesses in explaining ideas involving three dimensions. Mr. Mullins's book will give them some useful hints for making models in both clay and wax.

Mount Vesuvius: a Descriptive, Historical, and Geological Account of the Volcano and its Surroundings. By J. LOGAN LOBLEY, F.G.S. (Roper & Drowley.) Probably no volcanic region has been so long and so well observed as that around Vesuvius. The beautiful situation of the volcano in one of the fairest and most frequented parts of Italy, as well as the frequency and violence of the eruptions, have fixed the attention of mankind on the changes going on in the Bay of Naples. Pliny, Sir William Hamilton, and a long series of careful observers have noted the phenomena of successive eruptions, and speculated upon the causes at work. Prof. Lobley reviews at length the history of the mountain and of the neighbouring volcanic regions, and he gives a striking series of drawings of Vesuvius illustrating the changes which have taken place since the great eruption of A.D. 79, when Pompeii was destroyed. Perhaps the most interesting chapter is that in which Prof. Lobley reviews the various hypotheses of volcanic action which theorists have from time to time maintained—while admitting that active volcanoes are generally situated on the sea-coast, or beside rivers or lakes. He thinks that insuperable difficulties exist in explaining the method by which water can pass from the sea to a deep source of volcanic action, since open fissures would either not allow of water descending in the face of the stream that would force it back, or they would themselves be the channels of emission for the lava, so that volcanoes would be confined to the sea bottom. He dismisses as equally unsatisfactory the theory that water may reach the regions where the melted lava is stored by capillary transmission through rocks, while the lava can only issue by fissures in the rock; but at the same time he admits that immense quantities of steam issue from volcanic vents where lava is poured out, and that salt in considerable quantities is found with the Vesuvian minerals. He rejects the theory that the solid rocks form only a thin skin over a sea of melted lava, and is inclined to believe that there are local regions where the rocks are melted and occasionally reach the surface as lava. He assumes that "the primary cause of the formation of fluid lava is the internal heat of the globe inducing chemical, and possibly electrical, action in subterranean regions where the chemical composition of the rocks and their contained and associated minerals are favourable; and where, moreover, the conditions become more favourable by the removal of the restraining vertical pressure of the superincumbent rock masses, by the counteracting lateral or tangential pressure produced by secular cooling causing shrinkage."

Charts of the Constellations from the North Pole to between 35 and 40 degrees of South Declination. By ARTHUR COTTAM, F.R.A.S. (London: E. Stanford.) This magnificent series of stellar charts certainly forms one of the finest, if not *the* finest delineations of the stars visible to the observer in Central Europe. It is intended primarily for the possessors of telescopes which are not mounted equatorially. The owners of such telescopes have hitherto had

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much difficulty in picking up double, red, and variable stars, nebulæ, &c. not visible to the naked eye, owing to the absence of reliable maps by means of which most of them could be readily identified. In the present charts, which meet this long-felt want, nine-tenths of W. Struve's double stars, with a selection from the catalogues of his son and Mr. Burnham, most of the red stars in Mr. Birmingham's catalogue, nearly all the known variables, and a very large number of nebulæ and clusters from the catalogues of Sir William and Sir John Herschel are inserted for the epoch 1890, every star visible to the naked eye in the portion of the heavens charted being also given. We think, however, that, in the case of naked-eye pairs, Struve's, O. Struve's, or Burnham's numbers should have been attached, when the pairs in question were not too close or unequal to have been visible in instruments of moderate dimensions; or at least that some indication of their being double should have been given—as is the case in Proctor's maps, as well as the excellent atlas (too little known to Englishmen), the *Tabulæ Cælestes* of Schurig. The scale is very large, one-third of an inch to a degree of a great circle; and the charts being printed on drawing paper, any new objects can be easily inserted. One distinctive feature of the map is that every constellation—with the single exception of the unmanageable Hydra—is shown complete on a single chart. The charts number in all 36, in which the 57 constellations shown are included. Something of the kind was attempted in England many years ago, but, if we remember rightly, only the constellations of Orion and Lepus were issued, and the scheme eventually fell through. Mr. Cottam very wisely, considering the astonishing discrepancies between the drawings hitherto published, refrains from giving any delineation of the Milky Way. We are glad to hear that it is his intention to bring out a similar series of charts of the Southern Heavens, and we may then hope to see a large increase in the number of observers at the Antipodes.

The Southern Skies. By the late R. A. PROCTOR. (W. H. Allen & Co., London.) This is an atlas nearly uniform with Mr. Proctor's "Half-hours with the Stars," a guide to the Northern Heavens, which has gone through several editions. It contains twelve circular maps, each showing the principal constellations above the Horizon for different periods of the year. Mr. Proctor, who had a special gift for map drawing, had nearly completed this little atlas at the time of his death. An observer, lying on his back in Latitude 38 South, would see the stars at the centre of the maps directly over his head at the hours and dates mentioned, and the different constellations visible in their several places relatively to the horizon. Mr. Proctor points out that the atlas can be made use of for other latitudes than 38° S. by means of a piece of paper cut according to a diagram he gives, so as to cover up a portion of the map and show the stars along the southern horizon. The maps form an excellent introduction to the Southern constellations. An observer who wishes to explore the southern heavens will, after having made himself familiar with the principal stars by means of these maps, have no difficulty in finding smaller stars and nebulæ, by means of star catalogues and the larger star maps.

The Anatomy of the Frog. By A. ECKER, translated, with annotations and additions, by G. HASLAM. 8vo. (Clarendon Press, Oxford. 1889.) Pp. 1–449. Illustrations. The handsome volume before us is the second of a series in course of publication by the Clarendon Press, issued under the title of "Translations of Foreign Biological Memoirs." The letter-press and illustrations are excellent. We would especially call attention to the splendid execution of the two coloured plates illustrating the vascular anatomy of the Frog. The work is called a translation of Ecker's monograph, of which the first part appeared in 1864, and the second in 1882; but it is really a great deal more than this. Thus, the translator states that he has added extensively to the text, and also to the number of the illustrations; while the chapter on the Central Nervous System is entirely re-written, and the one following is re-arranged. The Frog is an animal of wide interest, as belonging to that class in which alone we find actual living examples of evolution; these creatures commencing life in a stage which is, to all intents and purposes, on the platform of the Fishes, while in their perfect state they are but little removed from true Reptiles. The Frog, as our author remarks, has also an adventitious interest, as being the unfortunate animal selected for the doubtful honour of so many physiological experiments; and it is, therefore, of great importance that its detailed anatomy should be fully and accurately known. The introductory chapter treats of the external contour of Frogs, as exemplified by the Edible Frog and the Common Frog (*Rana temporaria*). It is noticed that two species have been confounded under the latter name; the second one being termed *R. oxyrhinus*, although, according to Mr. Boulenger's British Museum catalogue, its right name is *R. arvalis*. In the first section of the work we have an elaborate description, with some excellent figures, of the bones of the skeleton. It is worthy of notice that the author terms the bony bar of the shoulder-girdle situated in advance of the coracoid the "clavicle," instead of the precoracoid. In this respect he follows Prof. Wiedersheim. Now, the latter writer identifies this so-called clavicle with the bone generally termed precoracoid in the Chelonia, which he likewise identifies with the clavicle. If, however, the epiplastrals of the Chelonian plastron are rightly regarded as the clavicles, it is quite clear that the deeper-seated pair of bones cannot also be clavicles; and since the latter bones are almost certainly the same as the so-called clavicles of the Frog, it seems to us that these two bones should be regarded both in the Chelonia and the Frog, as the precoracoids. We may direct attention to the curious sexual difference in the humerus of the Frog, so well shown in the illustration on page 41—a difference which is still more strongly marked in the South American genus, *Leptodactylus*. In calling the conjoint bones of the fore-arm "radio-ulnar" (p. 43), the translator evidently should have written radio-ulna, as he speaks of tibio-fibula on page 47. The following seven sections are devoted to the description and illustration of the soft parts, into the details of which we are prevented by want of space from entering. That this work is worthy to take rank with Straus-Durckheim's *Anatomy of the Cat*, and Prof. Mivart's later treatise on the same subject, we have no hesitation in saying. We regret, however, to find that no mention whatever is made of the Tadpole, and of the wonderful metamorphosis of the latter into the perfect Frog; and we think that the translator might well have added a chapter on this subject, and have shown us how the organisation of the larva is gradually modified into that of the adult. We may, however, venture to hope that this omission will be remedied in a future edition.

Index of British Plants, according to the London Catalogue (Eighth Edition). By R. TURNBULL. London. 1889. Pp. 1–98. 8vo. The popularity of this little work is sufficiently evidenced by its having reached its eighth edition. Such a guide will be found of considerable assistance to amateur botanists, in wading through the complex nomenclature with which this branch of natural science is weighted. Full reference to descriptions and figures are given, which, if accurate, must be of great

value. Whether, however, the plan of indicating the accentuation of technical names by diacritical marks and division into syllables is altogether an advisable one we are not fully assured.

Flower-Land: an Introduction to Botany. By ROBERT Fisher, M.A. (Bemrose & Sons.) This is an enlargement of a book which the author issued last year under the same name, and which met with a sufficiently favourable reception to tempt him to add to it a second and more advanced part. The present volume gives an excellent outline of Phanerogamic Botany in the simplest possible style and language. The technicalities which usually form so deterrent a feature in a first book on botany are, in the introductory part, smoothed over in a wonderful way, and the reader is only gradually introduced to a fuller terminology. The book is profusely illustrated with excellent cuts, and there is a constant appeal to nature, and to actual specimens to be hunted up from hedges, woods, and fields, that tends to check the acquisition of mere book-knowledge, and puts the tyro on the right path to become a practical and scientific botanist, should his inclinations travel in that direction. Young beginners in botany could not start with a better equipment than Mr. Fisher's "Flower-Land."

On the Causes, Treatment, and Cure of Stammering. By A. G. BERNARD, M.R.C.S., L.R.C.P. (J. & A. Churchill). According to the author, at least one in every thousand of the population of this country is a stammerer, but he is convinced that this proportion is needlessly great, and that persons so afflicted have in their own hands the power of cure. He was once an inveterate stammerer himself, but cured himself by the system he advocates in this manual. There are rules to be observed and exercises consisting of literary extracts and sets of words difficult of pronunciation to be repeated. Patience, perseverance, strict adherence to the rules, and careful practice of the exercises will, Mr. Bernard believes, produce in those suffering from this unpleasant defect proper control of the vocal organs, and enable them to speak without discomfort to themselves or their auditors.

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

BARNARD'S COMET (1884. II.).

To the Editor of KNOWLEDGE.

SIR,—In case anyone should think I ought to have included this comet amongst those "due in 1890," perhaps I may be allowed to point out the hopelessness of seeing it at the forthcoming return. Herr A. Berberich has published in the *Astronomische Nachrichten*, Nos. 2938-9, a very elaborate determination of its orbit, and finds that a perihelion passage will be due on the 10th of next month (January 1890); but he adds that the longitude of the perihelion is 306°, whilst that of the sun at the time will be 290°, and that the comet's angular distance from the sun, as seen from the earth, will scarcely exceed 9° during several months. At the following return, in the month of May 1895, the conditions of visibility will be somewhat more favourable. The author of the "Astronomical Column" in *Nature* for October 2, 1884, pointed out that this comet must have made a near approach to the planet Mars in the month of April 1868; this may of course have somewhat altered the period, and possibly it may after all be found that the comet is identical with De Vico's periodical comet of 1844, and with La Hive's comet of 1678, determined by Le Verrier to be elliptic and of short period.

Yours faithfully,

Blackheath, Dec. 11. W. T. LYNN.

P.S.—It has been pointed out to me that I overlooked, in my article, the investigation of the orbit of Mr. Denning's comet, which was published by Dr. B. Matthiessen of Carlsruhe, in *Ast. Nachr.*, No. 2903. Availing himself of an observation made at Strasburg on the 24th of November 1881, five days later than any previously published and used in the calculation, he found the probable period to be a little shorter than Mr. W. E. Plummer had done, and to amount to about 8·69 years, which would bring the comet to perihelion again in the month of May 1890, though the theoretical brilliancy will then be less than a third part of what it was when the comet was discovered by Mr. Denning in October 1881.

WILSON'S THEORY OF SUNSPOTS.

To the Editor of KNOWLEDGE.

SIR,—It is with great diffidence that I venture to express an opinion somewhat adverse to the statement of such a well-known observer of solar phenomena as the Rev. Mr. Howlett, which is contained in his letter published in the September number of KNOWLEDGE, and is to the effect that the Wilsonian theory of spots being depressions in the atmosphere is wrong. Certainly, on looking over several drawings of sunspots that I have from time to time made, my sketches of spots near the limb do not bear out Wilson's idea. I find, in fact, that no hard and fast line can be drawn respecting the appearance of a spot at the edge of the disc. One spot, for instance, which I observed not far from the E. limb, on July 9, 1881, had the penumbra arranged symmetrically round it during its progress across the sun's surface until July 17th, on which date it was about as far from the W. limb as it was from the E. limb when first seen. Its appearance now confirmed Wilson's theory, for much more of the penumbra was visible on the *following* side of the nucleus than on the *preceding* side. From this instance, which I might illustrate with one or two others, it appears to me that, just as Carrington was of opinion that there were two kinds of solar spots, "those which notably change their place on the sun's surface, and those which remain constantly at the same place," so we must conclude that there are spots considerably depressed below the level of the sun's surface, as well as those (perhaps the larger number) which are but slightly, if at all, depressed below the surface. It would be interesting to note whether the spectroscope reveals any difference in the nature of the spots that could be accounted for on the supposition that they differ in depth.—Yours faithfully,

Forest Gate, E. B. J. HOPKINS.

[The spots so frequently change in form as they pass across the disc, that one must not assume too readily that all changes of form on approaching the limb are due to perspective.—ED.]

THE FACE OF THE SKY FOR JANUARY.

By HERBERT SADLER, F.R.A.S.

WHENEVER the state of the sky during the past month has permitted the sun's disc being observed, the spots seen have been both few in number and small in size. Conveniently observable minima of Algol (*cf.* "Face of the Sky" for December 1888) occur at 9h. 48m. P.M. on the 3rd; 6h. 37m. P.M. on the 6th; 11h.

30m. P.M. on the 23rd; 8h. 18m. P.M. on the 26th; and 5h. 7m. P.M. on the 29th. Mimima of Lambda Tauri (*cf.* "Face of the Sky" for December 1888) take place at 11h. 0m. P.M. on the 3rd; 9h. 52m. P.M. on the 7th; 8h. 44m. P.M. on the 11th; 7h. 36m. P.M. on the 15th; 6h. 29m. P.M. on the 19th; 5h. 20m. P.M. on the 23rd; and 4h. 13m. P.M. on the 27th. The beautiful red star R Leonis (*cf.* "Face of the Sky" for March 1888) attains a maximum on the 30th. Mercury is visible as an evening star during the greater portion of the month, but is in a bad position for observation owing to his southern declination. On the 1st he sets at 5h. 1m. P.M., 1h. 1m. after the sun, with an apparent diameter of $5\frac{1}{4}''$, and a southern declination of 23° 9′. He is at his greatest eastern elongation (18° 51′) at 3h. A.M. on the 14th. On the 21st he sets at 5h. 58m. P.M., 1h. 30m after the sun, with an apparent diameter of $8\frac{1}{2}''$, and a southern declination of $14\frac{1}{2}°$. At 6h. P.M. on the 29th he is in inferior conjunction with the sun. During the month he passes from Sagittarius into Capricornus. On the evening of the 4th he will be near the 6th magitude star 4 Capricorni; at 3h. P.M. on the 13th he will be about $1\frac{1}{2}'$ *s.p.* the 4th magnitude star θ Capricorni. On this evening he sets at 5h. 58m. P.M. Venus is practically invisible. Mars is a morning star, rising on the 1st at 1h. 57m. A.M., with an apparent diameter of $6\frac{1}{2}''$, and a southern declination of $10\frac{1}{4}°$. On the 31st he rises at 1h. 30m. A.M. with an apparent diameter of 8″·0, and a southern declination of $15\frac{1}{2}°$. During the month he passes from Virgo into Libra, but does not approach any naked-eye star very closely. Vesta is in opposition to the sun on January 18th, when she rises at 4h. 24m. P.M., with a northern declination of $23\frac{1}{2}°$, and is then distant rather less than 140 millions of miles from us. Vesta will appear at this opposition as a $6\frac{1}{2}$ magnitude star, and is considered to be the largest of the minor planets. From photometrical determinations, Stone made the diameter of this minor planet 214 miles, Argelander 270, Pickering 319. By measurement of the disc Schröeter made the diameter 430 miles, Mädler 300, Tacchini (at the very favourable opposition of 1880, when he used a power of 1000 on the refractor at Palermo) 880 miles. Secchi, comparing it with the first satellite of Jupiter, estimated the diameter at 450 miles, and "*di colore ranciata carico.*" Vesta is situated a little to the N.W. of Præsepe at the beginning of the month, and describes a retrograde path through Cancer to the confines of Gemini. Jupiter is in conjunction with the sun on the 10th. Saturn is in a very favourable position for observation, rising on the 1st of the month at 8h. 33m. P.M. with an apparent diameter of 19″, and a northern declination of 11° 39′ (the major axis of the ring-system being $43\frac{1}{2}''$, and the minor $6\frac{1}{4}''$ in diameter). On the 31st he rises at 6h. 25m. P.M., with a northern declination of 12° 21′, and an apparent diameter of $19\frac{1}{2}''$ (the major axis of the ring-system being 45″, and the minor 7″ in diameter). On the evening of January 3rd Titan will be about 30″ *n.* a little *p.* the planet, and Iapetus will be at his greatest western elongation, at which time he is at his brightest. At about 11h. 30m. P.M. on the 11th Titan will be 29″ south of the planet, and on the evening of the 19th about 32″ *n.* a little *p.* At 8h. P.M. on the 21st Iapetus will be 19″ north of Saturn. At 11h. P.M. on the 22nd Rhea and Iapetus will apparently form one object. At 9h. 30m. P.M. on the 27th Titan will be 31″ south of Saturn. As Uranus does not rise till 20m. before midnight on the last day of the month, we defer an ephemeris of him till February. Neptune is still in a very favourable position for observation, rising on the 1st at 1h. 29m. P.M. with an apparent diameter of $2\frac{1}{2}''$, and a northern declination of 18° 58′. On the 31st he rises at 11h. 26m. A.M. He describes a very short path to the S.E. of 43 Tauri. January is a favourable month for the observation of shooting stars, the most important shower being the *Quadrantids*, the radiant point being in R.A. 15h. 12m., and 53° north declination, the greatest display being visible during the morning hours of January 1-3. The moon will be full at 5h. 37m. A.M. on the 6th, enters her last quarter at 6h. 33m. A.M. on the 14th, is new at 11h. 49m. P.M. on the 20th, and enters her first quarter at 8h. 16m. P.M. on the 29th. On the 2nd, at 11h. 3m. P.M., the $3\frac{1}{2}$ magnitude star ϵ Tauri will disappear at an angle of 178° from the vertex, and reappear at 11h. 57m. P.M. at an angle of 271°. On the 3rd the $5\frac{1}{2}$ magnitude star *l* (106) Tauri will disappear at 4h. 5m. P.M. at an angle of 13° from the vertex, and reappear at 4h. 40m. at an angle of 299°. At 4h. 12m. A.M. on the 4th the 6th magnitude star 114 Tauri will make a near approach to the lunar limb at an angle of 224°. At 5h. 20m. P.M. the same evening the 6th magnitude star 141 Tauri will disappear at an angle of 60° from the vertex, and reappear at 6h. 22m. at an angle of 242°; the 6th magnitude star 6 Geminorum disappearing at 11h. 35m. P.M. at an angle of 120°, and reappearing at 0h. 54m. A.M. the next morning at an angle of 286°. At 1h. 49m. on the morning of the 5th the $3\frac{1}{2}$ magnitude star η Geminorum will make a near approach to the lunar limb at an angle of 37°; and at 5h. 54m. A.M. the same day the 3rd magnitude star μ Geminorum will disappear at an angle of 49° from the vertex, and reappear twelve minutes later at an angle of 23°. At 9h. 26m. P.M. on the 6th the $6\frac{1}{2}$ magnitude star 84 Geminorum will disappear at an angle of 28°, and reappear at 10h. 39m. P.M. at an angle of 257°. At 4h. 16m. A.M. on the 7th the $6\frac{1}{2}$ magnitude star 7 Cancri will disappear at an angle of 135°, and reappear at 5h. 19m. A.M. at an angle of 279°. At 6h. 34m. the same morning the $5\frac{1}{2}$ magnitude star μ^2 Cancri will disappear at an angle of 75°, and reappear at 7h. 16m. at an angle of 340°. At 2h. 3m. A.M. on the 14th the 6th magnitude star 80 Virginis will disappear at an angle of 341°, and reappear at 2h. 48m. A.M. at an angle of 259° from the vertex. At 3h. 34m. A.M. on the 16th the 6th magnitude star o^1 Libræ will disappear at an angle of 3° from the vertex, and reappear at 4h. 30m. A.M. at an angle of 244°. At 6h. 24m. A.M. on the 17th the 5th magnitude star ψ Ophiuchi will disappear at an angle of 53°, and reappear at an angle of 234° at 7h. 35m. A.M. At 6h. 39m P.M. on the 24th the 5th magnitude star 30 Piscium will disappear at an angle of 152°, and reappear at 7h. 42m. at an angle of 328°; and the 5th magnitude star 33 Piscium will disappear the same evening at 8h 24m. P.M. at an angle of 131°, and reappear, the moon having set at the time, at 9h. 17m. P.M. at an angle of 356°. At 6h. 28m P.M. on the 29th the 6th magnitude star B.A.C. 1272 Tauri will make a near approach to the lunar disc at an angle of 8° from the vertex.

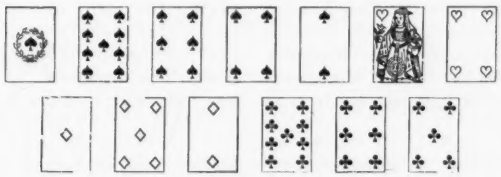
Whist Column.

By W. MONTAGU GATTIE.

DISCARDING INSTEAD OF TRUMPING.

IT is frequently advantageous to abstain from trumping a losing trick when a good discard can be made by passing it, or when it is not desirable to obtain the lead, or when the suit is one which partner wishes to clear. All these conditions are fulfilled in the following hand, which is taken from actual play.

HAND NO. 8.



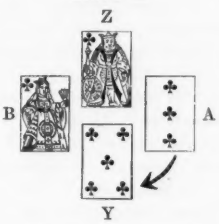
Y's Hand.

Score—Three all. Z turns up the ten of spades.

NOTE.—A and B are partners against Y and Z. A has the first lead; Z is the dealer. The card of the leader to each trick is indicated by an arrow.

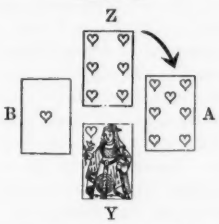
The notes appended to the tricks are supposed to be made during the play by the player whose hand is exposed. The subsequent remarks relate to the play generally.

TRICK 1.



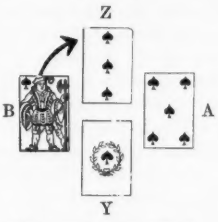
Tricks—AB, 0; YZ, 1.

TRICK 2.



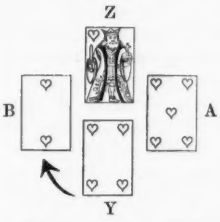
Tricks—AB, 1; YZ, 1.

TRICK 3.



Tricks—AB, 1; YZ, 2.

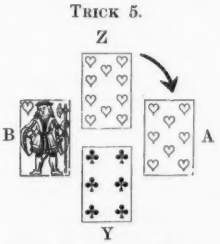
TRICK 4.



Tricks—AB, 1; YZ, 3.

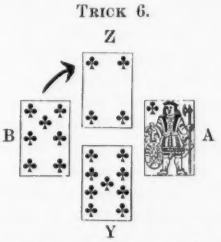
NOTE.—*Trick* 3.—It is already probable that AB have three honours between them, and therefore will win the game unless YZ can make two by cards. For B's lead must be either from five trumps to the knave, queen, king, or from weakness; so that, if Z had held queen or king, he would have known the knave to be a strengthening card led from weakness, and, with less than four trumps, would probably have covered it—especially as he holds the ten.

TRICK 5.



Tricks—AB, 2; YZ, 3.

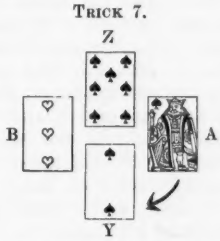
TRICK 6.



Tricks—AB, 3; YZ, 3.

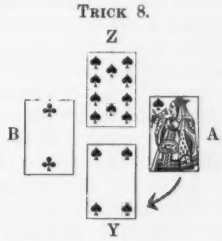
NOTE.—*Trick* 5.—Y wishes to retain his strength in trumps and also to avoid having the lead, which would necessitate his opening the diamonds. By passing the losing heart he enables his partner to clear that suit, and at the same time rids himself of a small card of the adversaries' suit. It will be seen presently that any other play should lose the game

TRICK 7.



Tricks—AB, 4; YZ 3.

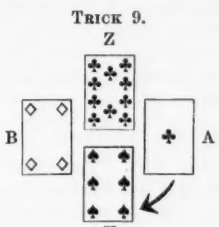
TRICK 8.



Tricks—AB, 5; YZ, 3.

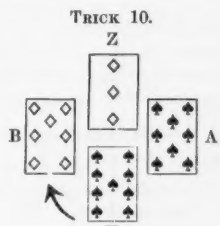
NOTES.—*Tricks* 7 and 8.—Z has the long heart, A has the eight of trumps, and B's remaining cards are all diamonds (B cannot have another club, for he returned the seven at trick 6, and now plays the deuce).

TRICK 9.



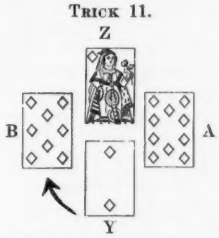
Tricks—AB, 5; YZ, 4.

TRICK 10.



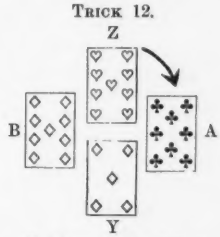
Tricks—AB, 5; YZ, 5.

TRICK 11.



Tricks—AB, 5; YZ, 6.

TRICK 12.



Tricks—AB, 5; YZ, 7.

NOTE.—*Trick* 11.—Z has the long heart and two diamonds; A has the long club and two diamonds; B has three diamonds. If Z has the king of diamonds, YZ win the game anyhow; but otherwise, they even lose the odd trick if Y leads ace and then a small one; for if B has the king, he will afterwards make the last diamond and, if A has the king, he will afterwards make his club. Y therefore leads a small diamond.

TRICK 13.—Y makes the ace of diamonds, and

YZ WIN TWO BY CARDS AND THE GAME.

A's Hand.	B's Hand.
S.—Kg, Qn, 8, 5.	S.—Kn.
H.—8, 7, 5.	H.—Ace, Kn, 3, 2.
C.—Ace, Kn, 8, 3.	C.—Qn, 7, 2.
D.—Kn, 10.	D.—Kg, 9, 8, 7, 4.
Y's Hand.	**Z's Hand.**
S.—Ace, 9, 6, 4, 2.	S.—10, 7, 3.
H.—Qn, 4.	H.—Kg, 10, 9, 6.
C.—9, 6, 5.	C.—Kg, 10, 4.
D.—Ace, 5, 2.	D.—Qn, 6, 3.

REMARKS.—*Trick* 3.—B no doubt thought himself fairly safe in every suit; but there seems no justification for the

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trump lead. If he had opened his diamonds in the ordinary way, AB must have won the game and would probably have obtained the odd trick.

Trick 4.—Z dare not finesse, for he does not know that B's lead to trick 3 was not from great strength in trumps.

Trick 5.—If Y trumps here, he must continue with a diamond. Supposing him to lead a small one (the most favourable case), Z, after winning with the queen, could do no better than give him another force in hearts, and the only other card YZ could make would be the ace of diamonds, which would only give them the odd trick.

Trick 6.—At this point, B plays correctly, we think, in returning the club suit instead of opening the diamonds, as it is desirable to throw the lead into A's hand.

Trick 9.—But here A, in his turn, throws away the game. B can have nothing but diamonds, and the knave would almost certainly be a very useful card to him. It would clearly have been better to lead through Y than to let him lead through B. As the cards actually lay, a diamond lead must have won the game for AB; for, even if Y had held up the ace and B had finessed, Z on getting in with the queen could have done no better than to lead the long heart; A would have trumped of course, and Y, after over-ruffing, would have had no opportunity of ridding himself of his small diamond.

ELEMENTARY EXPLANATION OF THE PLAY.

Trick 1.—A opens his strongest suit. The card led being a small one, it is clear that he is not leading from a weak suit of three or less, in which case he would have led the highest. Consequently all the players infer that A has at least four clubs.

Trick 2.—Similarly, all the players now infer that Z has at least four hearts, of which three are better than the six. A plays the seven instead of the five, to save his partner's hand, in case Y should prove very weak in the suit. This is not intended as a call for trumps, but it is so likely to be taken in that sense that it is rarely safe to play so low a covering card as the seven unless fairly strong in trumps. As A holds four trumps to two honours, he is justified in running the risk that B may think he has "called."

Trick 3.—B has good diamonds, and the second-best heart twice guarded, and his partner has shown strength in clubs. He therefore leads his single trump. But he would, no doubt, have done better to open his long suit.

Trick 4.—Y returns his partner's lead. It is clear to him from this trick that the knave of hearts is with A or B, for if Z had held it he would have played it instead of the king, in accordance with the rule that a trick should always be won with the lower of two indifferent cards.

Trick 5.—Y discards a club, in preference to trumping the trick. The student should observe that nothing is lost by this; for Y at the same time disposes of a losing card in A's strong suit. If Y had trumped, B would have held up his knave, and Z's suit would not have been cleared.

Trick 6.—B returns his partner's lead with the higher of two remaining. A, in accordance with the rule just explained, wins with the knave. The ace is now marked in his hand; whereas, if he had played the ace, no one at the table could have told where the knave was.

Tricks 7 *and* 8.—A responds to his partner's trump lead by drawing two rounds. B's discards show that his other cards are all diamonds. For Z must have the remaining heart (see note to Trick 2); and, as B, after returning the seven of clubs (Trick 6), now plays the deuce, he can only have held three originally. Unless Z's ten of spades is a false card (which is not likely), it is now clear to A that Y holds the nine and the six, while Y, on his part, can place the eight with A.

Trick 9.—A leads the club to force a trump from Y; but, as it is certain that Y, after drawing the eight of trumps, will lead diamonds through B, it would have been much better to open the diamond suit at once with the knave, so as to assist B as much as possible. The remainder of the play is fully explained in the note appended to Trick 11.

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*Whist** is the brief but sufficient title of a neat little book by Dr. Pole, which has just been reprinted from the new edition of Bohn's *Handbook of Games*. It aims at giving a *résumé* of the leading maxims of play laid down by Hoyle, Payne, Mathews, Clay, and "Cavendish," together with illustrations of their application, selected from the treatises of the same authors and of General Drayson. The idea of bringing into a single volume all that is best worth preserving in the earlier works, together with a description of the more exact methods of modern times, is in itself an excellent one; and the experience and ability of the compiler are a guarantee that it has been carried out with care and discrimination. It is well known that Dr. Pole is a disciple of the "modern school"; but he wisely refrains from discussing at any length, or unduly insisting upon, its peculiar dogmas, and the "plain-suit-echo" is not even mentioned. The book, in fact, is addressed to learners, and in that light we proceed to criticise it.

The means of conveying information are divided into four classes—namely, "ordinary rules," "uniformity of play," "irregular play," and "conventions"; but the principles on which the distinctions are drawn are not always quite clear. Why, for instance, should the play of king, third in hand, when holding ace also, be assigned to the first class, and the play of four, from both four and five, to the second? Surely both cases are examples of the general convention that the lower of two indifferent cards should always be played by everyone except the leader. The signal for trumps and the American leads are classed as "conventions." It might be contended that every rule of play is a convention; but, since other headings are given, we should certainly have expected the signal for trumps to appear under "irregular play," and the American leads under "uniformity of play." The signal for trumps consists essentially in the play of a false card, and can only be justified in theory as an unlimited extension of an obvious artifice for deceiving the adversaries. The American leads, on the other hand, are usually supported on the ground that they substitute a uniform and scientific code for a number of previously isolated dogmas. It is difficult, again, to understand why the natural lead of queen from a tierce major in trumps should be described as irregular play, while the inference that the leader of a king in plain suits has also either ace, or queen, or both, is set down among the ordinary rules, and the lead of ace before king from those two cards alone is included with the "conventions."

The maxims are arranged in the chronological order of the books from which they are taken; but it would, we think, have been better, in the interests of the student, to group them systematically. There is a risk of his becoming confused, or at least wearied, in the endeavour to master a number of miscellaneous precepts between which there is no apparent cohesion. He may also be perplexed, in the absence of any explanation, at seeming inconsistencies in the advice offered. Thus, on page 59, Dr. Pole quotes from Clay as follows:—"Do not play false cards. The habit, to which there are many temptations, of trying to deceive your adversaries as to the state of your

* *Whist.* By Dr. W. Pole, F.R.S. London: George Bell & Sons. 1889.

hand, deceives your partner as well and destroys his confidence in you. A golden maxim for whist is, that it is of more importance to inform your partner than to deceive your adversary. The best whist player is he who plays the game in the simplest and most intelligible way. I hold in abhorrence playing false cards. . . . You have ace and king of a suit, and you take the trick with your ace. This is probably in your adversary's suit, for you would hardly think it right to deceive me in my own; but you cannot resist the temptation of taking in your opponent. What is it you have done? You have told me, as plainly as whist language can speak, that you do not hold the king. . . . Perhaps I fear to lead trumps, because I believe that the suit in question is wholly in the possession of my adversaries. I should have led them if I had thought it possible that you could protect me in that suit. Or it may be that I am sorely put to it to find one trick in your hand with which to save the game. Be sure that the last suit in which I shall look for it will be that in which you have told me that you were unable to resist say a knave or a ten at a cheaper price than your ace. Again, believing that the king is held by my opponents, and being probably able to say in which of their hands it ought to be, I miscount the numerical strength of all the players in all the suits, until at last I find that my partner has paid me the ill compliment of believing that I am likely to play as well with my eyes shut as open."

All this is excellently put. But, a few pages further on, we find a very different doctrine quoted from Hoyle. "If," says that authority, "your right-hand adversary lead from a suit of which you have ace, king, queen, or ace, king, knave, put on the ace, because this will encourage them to play the suit again. It is true you deceive your partner by this method, but it is of more consequence here to deceive your adversaries. If you play the lower one they will discover that the strength of the suit is against them, and will change the suit." What, then, is the student to conclude from these contradictory arguments? The explanation is really contained in a terse maxim of Mathews', which appears on another page. "Play as clear a game as possible when your partner has a good hand. But, when the winning cards lie between you and your adversaries, you may play an obscure game." It is too much to expect a beginner to sort in his mind kindred precepts appearing in different places, and to discover for himself how their discrepancies may be reconciled.

Some of the maxims seem to need qualification, as, for instance, this one from Hoyle:—"If you hold two small trumps only, with ace and king of two other suits, and a deficiency of the fourth suit, make as many tricks as you can immediately." Hoyle's rules for unblocking a partner's suit also require some revision; and further illustrations of the importance of unblocking might with advantage have been added to the "special examples of play." These examples form the most interesting and useful feature of the book. The following is given by Mathews from actual play.

The parties each wanted only the odd trick to win the game. A, the leader, had won six tricks, and remained with knave and one small trump and two diamonds. Y, his left-hand adversary, had queen and ten of trumps, and two clubs. B, A's partner, had two small trumps and two diamonds. Z, last player, had ace and one small trump, one club, and one heart. A led a diamond, which, being passed by Y, was to be won by Z. But Z had to consider that, unless he made every trick, he would lose the game. And he saw that, unless Y had either the two best trumps, or the first and third with a successful finesse, this was not possible. He therefore trumped with the ace, led the small one, and won the game.

We have only space for one other specimen, which is taken from General Drayson's treatise. Nine tricks had been played, and the trumps were all out. Hearts had not been led or thrown. A and B wanted all the remaining tricks to save the game. A (fourth player) held ace, king, knave, and two of hearts. B (his partner) had shown that he held two long clubs, and two hearts unknown. Y (A's left-hand adversary) led a small heart; B played the seven; Z played the ten. A reasoned that after he had won the first trick, unless B could be given the lead in the next trick, so as to bring in his two long clubs, the game must be lost, as his two of hearts must ultimately be taken by one of the adversaries. As the only way of accomplishing this, he took the ten with the ace, and led the two, hoping B might win it with the queen. As it happened, Y had the queen; but, supposing B had the king, he played a small one, when B won the trick with the nine, and saved the game.

A useful glossary of terms used in whist concludes the book; and altogether, in spite of the defects of arrangement to which we have alluded, whist-players of all classes who expend a shilling in purchasing it will certainly obtain full value for their money.

Chess Column.

By W. MONTAGU GATTIE.*

[Contributions of general interest to chess-players are invited. Mr. Gunsberg will be pleased to give his opinion on any matter submitted for his decision.]

OUR opinion is asked by Mr. M. N. Kuka, of Bombay, on the following interesting and, so far as we are aware, entirely novel variations.

In the King's Knight's opening, after—

WHITE.	BLACK.
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to QB3
3. B to B4	

Black has, according to the books, the choice of three moves, viz. 3 . . . B to B4 (the Ginoco Piano), 3. Kt to B3 (the Two Knights' Defence), and 3 . . . B to K2 (the Hungarian Defence). Mr. Kuka proposes, instead of any of these—

	3. Kt. to Q5

And continues the game as follows:—

4. Kt × P	4. P to Q4
5. B × P, or (A)	5. Q to Kt4
6. Kt × P	6. Q × KtP
7. R to Bsq	7. B to Kt5, or (B)
8. P to KB3	8. B to K2, and wins.
Variation A.	
5. P × P	5. Q to Kt4
6. Castles	6. B to R6
7. P to Kt3	7. Q × Kt
8. R to Ksq	8. Kt to B6 (ch), and wins.
Variation B.	
	7. B to R6
8. B to B4	8. Q × KP
9. B to K2	9. Kt × QBP (ch), and wins.

(Black's last move in Variation B is obviously a slip, for 9 . . . Kt to B6 mates at once.)

Mr. Kuka rightly observes that White's best course at move 6 is to play P to QB3, and he thinks that this move should win if followed by 7. Q to R4 (ch). He remarks, also, that White does not seem to gain any substantial advantage by playing Kt × Kt or Castles at move 4; but it may be pointed out that, in the former case, the position becomes similar to that resulting from Bird's defence to the Ruy Lopez, with the difference that the White Bishop is better posted at B4 than at Kt5.

* Mr. Montagu Gattie has kindly undertaken the chess column while Mr. Gunsberg is in Havannah, where he has gone to play a match with the celebrated Russian player, M. Tschigorin.—EDITOR.

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Another good continuation for White at move 4, if he is not inclined to run the risk of taking the King's Pawn, is P to B3, which leaves Black no other course than to exchange Knights, after which White, retaking with the Queen, will be slightly ahead in the development. Let us assume, however, that he has captured the King's Pawn, and that, after taking the Queen's Pawn with his Bishop (clearly the best move), he plays 6. P to QB3. Black may now take either the Knight or the Knight's Pawn with his Queen.

In the first place:—

6. P to QB3	6. Q × Kt

In this case, it is very doubtful whether White should give the check. For example:—

7. Q to R4 (ch)	7. P to B3 (best)
8. P × Kt	8. Q to Q3

Better than 8 . . . Q to B2, which would be met by 9. Q to B2.

9. Kt to B3

If 9. B to Kt3, then 9 . . . P to QKt4, 10. Q to R5, Q × P, and White has an uncomfortable game.

	9. P to QKt4
10. Q to R5 (apparently best)	10. P × B
11. Kt × KtP	11. Q to B3
12. P × P	12. Q to Kt2

And, although White has the advantage, it will not be easy for him to win with his ragged Pawns.

On the other hand, by playing—

7. P × Kt	7. Q × P
8. Q to Kt3	

he at once obtains a decisive superiority. If now 8 . . . B to K3, then 9. B × B, Q × P (ch), 10. K to Qsq., &c.

In the second place:—

6. P to QB3	6. Q × KtP
7. Q to R4 (ch)	7. P to B3 (best).

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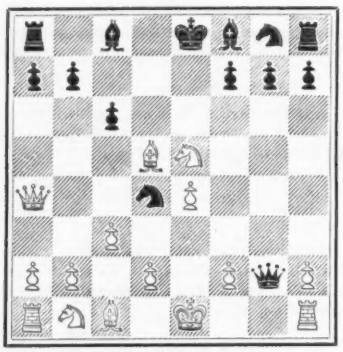


WHITE.

In this position White's best course seems to be

8. B × P (ch)	8. K to K2
9. Q to Kt4 (ch)	9. K to B3
10. Q × Kt	10. Q × R (ch)
11. K to K2	

Black has now the choice of several moves, of which 11. . . . B to Kt5 (ch) and 11 . . . Kt to R3 look the most promising; but in any case White appears to have a winning advantage.

Returning to the position on the diagram, and supposing White to play

8. P × Kt,

we believe Black may reply by 8 . . . B to Q2, with a fair prospect of making good his defence; but if he captures the Queen's Bishop, he will lose in a few moves; *e.g.*

	8. Q × B
9. Kt to Q B3	9. Q × R
10. B × P (ch)	10. K to Qsq
11. Q to R5 (ch)	11. P to Kt3
12. Kt × P (ch)	12. K to B2
13. Q to K 5 (ch), &c.	

Mr. Kuka has developed the same idea as a variation of the Vienna game, the opening moves being

WHITE.	BLACK.
1. P to K4	1. P to K4
2. Kt to QB 3	2. Kt to KB3
3. B to B4	3. B to B4

Of course, the same position is arrived at in a variation of the Berlin Defence to the King's Bishop Opening. Mr. Kuka now proposes

4. Kt to Q5

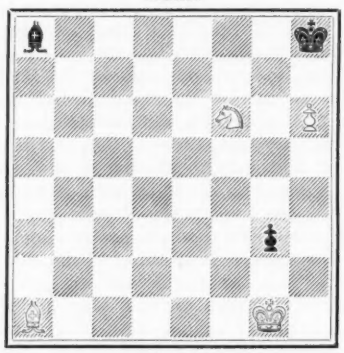
We think that this move may be met by P to QB3 even more advantageously than before, as the adverse bishop is not so well posted at QB4 as on his own square. But, to continue the variation as suggested by Mr. Kuka, let Black play

	4. Kt × P
5. P to Q4	5. B × P
6. Q to Kt4	6. P to QB3
7. Q × KtP	7. P × Kt
8. Q × R (ch)	8. K to K2
9. Q × Q (ch)	9. K × Q
10. B × P	10. Kt × P
11. Kt to B3	11. Kt × R
12. Kt × B	12. P × Kt
13. B × BP	13. K to K2 (?)
14. B to Kt8	14. P to KR4
15. B to Kt5 (ch)	

and Mr. Kuka remarks that White wins, "because the Black Knight cannot escape, and the other black pieces are still at home." But, if instead of Black's 13th move, which we have marked with a query, he play 13 . . . P to Q3, it is difficult to see how White is to obtain any advantage. 14. B to Kt5 (ch) and 15. B to R4 seem to be necessary moves in order to secure the Knight, and Black, after playing his King to B2, may continue with B to B4 and Kt to B3, having by no means a bad game. This result, however, does not detract from the credit due to Mr. Kuka for his original and interesting suggestions.

The following is an amusing end-game puzzle:—

BLACK.



WHITE.

White to play. In how many moves can he force a mate?

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Diagram showing the Distances of all Stars whose Parallaxes have been Determined during the Present Century.

When more than one parallax has been obtained a line is drawn through the star joining the various determinations, and the star disc is placed in a position intended to indicate different weights for the various determinations. Three or four obviously erroneous determinations have been omitted from the diagram, but they will be found in the printed list. The sun is supposed to be at the centre of the circle. A distance of 10 millimetres (one-tenth of the radius of the outer circle) corresponds to a parallax of a second of arc, and a distance of 20 millimeters to a parallax of half a second. For stars on the outer circle a parallax of a tenth of a second or less, and in some cases a negative parallax, has been found. The light from stars with a parallax of a tenth of a second would occupy about $32\frac{1}{2}$ years in reaching the earth. The stars are arranged as nearly as possible in order of right ascension.

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